European Commission

JRC SCIENTIFIC AND POLICY REPORTS

SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

2013 Assessment of Black Sea stocks (STECF 13-20)

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This report was reviewed by the STECF by written procedure in October 2013

Report EUR 26228 EN

Joint Research Centre

European Commission
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JRC85367

EUR 26228 EN

ISBN 978-92-79-33772-7

ISSN 1831-9424

doi:10.2788/34535

Luxembourg: Publications Office of the European Union, 2013

How to cite this report:

Scientific, Technical and Economic Committee for Fisheries (STECF) – 2013 Assessment of Black Sea stocks (STECF 13-XX). 2013. Publications Office of the European Union, Luxembourg, EUR 25309 EN, JRC 85367, 429 pp.

Printed in Italy

TABLE OF CONTENTS

SCIENTIFIC, TECHNICAL AND ECONOMICCOMMITTEE FOR FISHERIES (STECF)

Assessment of Black Sea Stocks (STECF-13-20)

THIS REPORT WAS REVIEWED BYTHE STECF BY WRITTEN PROCEDURE IN OCTOBER 2013

Request to the STECF

STECF is requested to review the report of the **EWG-13-12** held from September 30th to October 4th, 2013 in Ispra (Italy), evaluate the findings and make any appropriate comments and recommendations.

STECF observations

STECF reviewed the report of the EWG 13-12 and noted the progress made regarding the assessment of Black Sea stocks. STECF acknowledges the considerable efforts of the WG participants in undertaking its work.

The EWG 13-12 attempted to develop quantitative stock assessments for nine species but only five of the assessments (sprat, turbot, whiting, dogfish, and red mullet) are of sufficient quality to provide analytical estimates of recent exploitation rates and stock status in relation to proposed biological reference points. The assessment results for whiting and piked dogfish, however, are not sufficiently reliable to be used as a basis for short-term catch forecasts. The assessment results for horse mackerel and anchovy are less reliable and indicative of relative trends only. The assessments for Atlantic bonito and rapa whelk, which were explorations of the available data, are inconclusive with respect to stock status.

STECF conclusions

STECF concludes that the EWG 13-12 has adequately address all of its Terms of Reference and endorses the Report. STECF considers that the results presented in the Report of the EWG 13-12 represent the most comprehensive assessments of the current state of selected commercially-exploited stocks in the Black Sea.

Based on the review of the report of the EWG 13-12 STECF also concludes the following:

- Striped red mullet (*Mullus surmuletus*) and horse mackerel (*Trachurus trachurus*) should be excluded from the list of stocks to be considered during the Black Sea EWG meeting in 2014.
- The expansion of demersal and hydroacoustic surveys to cover a greater proportion of the Black Sea should be encouraged; there is a need for better coordination of the existing national surveys at the international level.
- There should be a review of the fishery sampling programs of the Black Sea nations to document how the fishery and stock assessment data in the Black Sea are collected and to identify the causes of the data gaps, which were apparent in the information provided to EWG 13-12.
- Mechanisms should be established for all Black Sea stocks to ensure that age-reading specialists in the different national laboratories all use the same agreed protocols for determining the age-readings. Procedures should be developed to assure that the age-readings are maintained to an acceptable quality standard. International workshop on otolith reading should be organised.

- Studies should be conducted to compile and review available information on the stock structure for all Black Sea stocks, which would be used as basis for providing scientific advice.
- There should be an increase of the at-sea sampling of the sprat fishery in order to document discards of whiting and other bycatch species.
- Members of the Black Sea EWG which were involved with the assessment of turbot should participate in the GFCM workshop that will prepare to implement a fishery management plan for turbot in the Black Sea.
- The EU Data Collection Program should include rapa whelk in its list of species that are subject to fisheries sampling.

STECF advice

Based on the findings of the STECF EWG 13-12, STECF proposes the following limit reference pointsas appropriate proxies for F_{MSY} and which are consistent with high long-term yields.

- Sprat: $F_{MSY} = F \leq 0.64$, consistent with the exploitation rate $E \leq 0.4$.
- Turbot: $F_{MSY} = F \leq 0.26$.
- Whiting: $F_{MSY} = F \leq 0.40$.
- Dogfish: $F_{MSY} = F \leq 0.18$.
- Red mullet: $F_{MSY} = F \leq 0.46$.

In relation to the above reference points, the current status of these species in the Black Sea and the associated STECF advice is as follows:

- **Sprat:**Fishing mortality in 2012 is estimated to be F=0.40, which is below the proposed FMSY reference point and lower than the peak F values estimated for 2010 (F=0.75) and 2011 (F=1.12) when the stock was subject to overfishing. STECF advises that in order to achieve the objective of MSY, fishing mortality on sprat should be maintained at $F \leq 0.64$. To achieve exploitation rates for sprat in 2014 that are consistent with the proposed F_{MSY} reference point, catches of sprat from the Black Sea in 2014 should not exceed 64,544 t. As there is no international allocation key for sprat, no advice is provided on a specific EU TAC for sprat.
- **Turbot:** Fishing mortality in 2012 is estimated to be F=0.85, which is more than three times the proposed F_{MSY} reference point. Moreover fishing mortality has exceeded F_{MSY} for many years and the stock is severely depleted. STECF advises that in order to achieve the objective of MSY, fishing mortality on Turbot in the Black Sea should be reduced to $F \leq 0.26$ and maintained at that level in the future. Given the severely-depleted nature of the stock, and to be precautionary, STECF considers that fishing for turbot in the Black Sea in 2014 should not be permitted and any individuals caught should be promptly released back into the sea.
- **Whiting:**The fishing mortality in 2012 is estimated to be F=0.96, which is more than double the proposed F_{MSY}. STECF advises that in order to achieve the objective of MSY, fishing mortality on whiting in the Black Sea should be reduced to $F \leq 0.40$ and maintained at that level in the future.Catch forecasts for 2014 were not calculated for whiting because the assessment results are not sufficiently reliable to be used as a basis for such forecasts. Consequently, STECF is unable to quantify the catches of whiting from the Black Sea for 2014 that are consistent with the proposed F_{MSY} reference point.
- **Piked dogfish:**The fishing mortality rate during 2012 is estimated to be F=0.24, which is more than the proposed F_{MSY}. STECF advises that in order to achieve the objective of MSY, fishing mortality on piked dogfish in the Black Sea should be reduced to $F \leq 0.18$ and maintained at that level in the future.Catch forecasts for 2014 were not calculated for piked dogfish because the assessment results are not sufficiently

reliable to be used as a basis for such forecasts. Consequently, STECF is unable to quantify the catches of piked dogfish from the Black Sea for 2014 that are consistent with the proposed F_{MSY} reference point.

- **Red mullet:**The fishing mortality rate during 2012 is estimated to be F=0.91, which is more than double the proposed F_{MSY}. STECF advises that in order to achieve the objective of MSY, fishing mortality on red mullet in the Black Sea should be reduced to $F \leq 0.46$ and maintained at that level in the future.STECF advises that to achieve exploitation rates for red mulletin 2014 that are consistent with the proposed F_{MSY} reference point, catches of red mullet from the Black Sea in 2014 should not exceed 467 t. As there is no international allocation key for red mullet, no advice is provided on a specific EU TAC.

Expert Working Group report

REPORT TO THE STECF

EXPERT WORKING GROUP ON ASSESSMENT OF BLACK SEA STOCKS (EWG-13-12)

Ispra, Italy, 30 September - 4 October 2013

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

1 EXECUTIVE SUMMARY

In response to the ToR the STECF EWG 13-12 on Black Sea stock assessments has endeavouredto develop stock assessments for nine stocks: sprat, turbot, whiting, horse mackerel, anchovy, piked dogfish, red mullet, Atlantic bonito and rapa whelk. Relevant data were compiled and reviewed, including those called officially by DG Mare through the 2013 DCF data call for the Mediterranean and Black Sea. Expert knowledge completed the data,which were analyzed using a variety of stock assessment approaches. The data and methods applied to the nine stocks are documented in section 6 of the present report.

Among the nine stocksthat were considered, assessments for five of the stocks (sprat, turbot, whiting, dogfish and red mullet) resulted in analytical estimates of exploitation during 2012 relative to estimated F_{MSY} reference points, consistent with high long term yields and low risk of stock collapse. The assessment results for whiting and piked dogfish were not sufficiently reliable to provide a basis for short-term catch forecasts. The assessment results for Mediterranean horse mackerel and Black Sea anchovy were also considered to be less reliable and indicative of relative trends only. The assessments for Atlantic bonito and rapa whelk, which were explorations of the available data, were inconclusive with respect to stock status.

STECF EWG 13-12 reviewed gaps in current knowledge and data, evaluated the progress made in addressing such gaps since last year, and formulated recommendations for addressing such gaps in the future. Some of the gaps that were identified were: limited survey coverage to provide tuning indices for the assessments; inadequate sampling of the landings for information on age composition and at sea for information on discards; and uncertainty whether there are multiple stocks of a given species within the Black Sea, and the boundaries that would separate these stocks.

In addition to the section with detailed assessments for each of the nine stocks, the present report provides a section with an overall summary of the EWG's findings and conclusions, a section with follow-up items that may improve the process for producing the next set of Black Sea stock assessments, and a section with a short summary sheet for each of the nine stocks that describe the stock and the status of its fisheries, and catch projections as appropriate.

The EWG gratefully acknowledge the valuable assistance of Dr. Aysun Gümüş, who provided data, analyses and text for the report, but was unable to attend the EWG 13-12 meeting. Numerous other individuals also contrributed to the activities and success of the EWG meeting.

2 FINDINGS AND CONCLUSIONS OF THE WORKING GROUP

The Working Group had little time during the meeting in Ispra for detailed discussions of the data or the assessment results, because most of meeting time was needed for assembling and analysing the information provided for the nine stocks that the Group considered. However, some issues were debated and noted by the Chair. After the meeting the Working Group conferred by email correspondence and agreed to the following items, which are organized in terms of findings and resulting conclusions.

2.1 General Findings & Conclusions that Apply to More than One Stock

Finding: Striped red mullet (*Mullus surmuletus*)and horse mackerel (*Trachurus trachurus*).

All the national experts agreed that catches of striped red mullet (*Mullus surmuletus*)and horse mackerel (*Trachurus trachurus*) are currently insignificant in the Black Sea and these species have never been a significant component of any fisheries in the Black Sea. The horse mackerel species that is wide-spread in the Black Sea is the Mediterranean horse mackerel (*Trachurus mediterraneus*).

> Conclusion: There is no reason to include Striped red mullet (*Mullus surmuletus*)and horse mackerel (*Trachurus trachurus*) in the Terms of Reference for the next and subsequent meetings of the Black Sea EWG.

Finding: Uncertainty regarding stock boundaries.

The stock assessments conducted by the EWG generally treated all the fish of a given species as being part of a single Black Sea stock. However, the Working Group was not provided with evidence to either support or refute the assumption that all the sprat (for example) caught in the Black Sea are from a single stock. Some national experts expressed the opinion that the fish occurring within their national waters were a unique stock, implying that these fish did not intermingle with the fish in the waters adjacent to their nation. While it is implausible that fish respect national boundaries, it is also true that there is little conclusive evidence to support the assumption that the Black Sea only supports single stocks of all the species that the Working Group considered.

Conclusion: Additional work is needed to compile and review available information that would provide a scientific basis for the stock structure of the fish stocks in the Black Sea. Results from genetic studies would provide the most definitive proof, but meristic studies might also provide an adequate basis for determining whether there are multiple stocks of turbot (for example) in the Black Sea.

Finding: Poor coverage by surveys.

Many of the stock assessments were limited by a general lack of tuning indices. This was a significant problem for the pelagic species in particular. In 2008 it was agreed that Bulgaria and Romania each year would jointly implement two bottom trawl surveys and two acoustic surveys in the EU waters of the Black Sea. The surveys were conducted in 2011, but in 2012 no surveys were conducted.

Conclusion: The issues that prevented the surveys by Bulgaria and Romania during 2012 need to be resolved so that this important source of fisheries independent data will available on a consistent and routine basis.

Finding: Uneven sampling for age-at-length or age-composition.

Catch-at-age matrices are fundamental information for stock assessments. To construct the catch-at-age matrices, the assessment coordinators often had to borrow age-length keys from other nations or from surveys because the sampling of the landed catch was erratic or completely missing. Age-length keys reflect the characteristics of the fishing gear that caught the fish and also the traits of the fish population that was being fished. The age-length keys will provide an inaccurate reflection if applied to fish caught with a different gear or from a different segment of the population. As a general rule, the practice of borrowing age-length keys should be avoided because it can result in biased estimates of catch-at-age.

Conclusion: A review of the national fishery sampling programs is needed to document how the fishery information is being collected and to identify the causes of the data gaps that were apparent in the information provided to the Working Group.

Finding: Age-readings may be inconsistent between national laboratories.

For some stocks there is circumstantial evidence that the age-reading techniques differ between the national laboratories (e.g., discrepancies were apparent in mean length-at-age).

Conclusion: A mechanism is needed to ensure that age-reading specialists in the different national laboratories all use the same agreed protocols for determining the age-readings. Procedures are needed for assuring that the age-readings are maintained to an acceptable quality standard.

2.2 Stock-Specific Findings & Conclusions

Sprat

Finding: Sprat is a relatively short-lived pelagic species and catches are predominately age-1 and age-2 fish. Fish that are 4 years or older are rarely caught. Discards of sprat are evidently very low. Most of the reported landings of sprat since 2003 were taken by Turkey (42%).

Finding: For the period 1993 to 2012 catches of sprat in the Black Sea increased steadily from a low level of about 17 thousand tons in 1993 to a first peak level of about 72 thousand tons in 2002, and a subsequent peak of almost 121 thousand tons in 2011. Catch during 2012 was only 35 thousand tons.

Finding: The Integrated Catch Analysis (ICA) method was applied to catch-at-age data assembled for the entire Black Sea for the period 1993 to 2012.

> Conclusion: The EWG endorses the stock assessment for sprat and considers that the stock was exploited unsustainably during 2010 and 2011. The catch forecast for 2014 based on the accepted proxy for F_{MSY} (exploitation ≤ 40%) is 64 544 t, which is less than the catch forecast under status quo fishing.

Finding: There is concern that the fishery for sprat produces significant quantities of bycatch and discard of other fish species, such as whiting.

> Conclusion: There should be increased sampling of the sprat fishery by at-sea observers to quantify the amount of bycatch and discarding.

Turbot

Finding: Turbot is a relatively long-lived demersal species and catches are predominately age-4 to age-6 fish. Discards of turbot in the directed fisheries are considered to be negligible. Most of the reported landings of turbot since 2003 were taken by Turkey (57%).

Finding: For the period 1950 to 2012 the annual catches of turbot dropped from an average of about 4000 t during the 1950s and 1960s to an average of about 2000 t during the 1990s and 2000s. Except for a slight increase in catch in 2012, the annual catches have declined steadily since 2006.

Finding: The State-space Assessment Model (SAM)approach was applied to catch-at-age data for age-classes 2 to 10+ from the period 1950 to 2012 for the entire Black Sea. The estimated F for 2012 is near the historical high level (0.85) and is more than three times the estimated F_{MSY} (0.26).

> Conclusion: The EWG endorses the stock assessment for turbotin the Black Sea and considers that the stock has been exploited unsustainably in recent years and remains at risk of collapse. Fishing mortality remains at high levels with no sign of reduction, despite the recently low TACs.

Finding: The stock assessment assumed that all turbot in the Black Sea are part of a single stock, but some members of the Working Group questioned the validity of this assumption. The Group was not provided with strong evidence either that there are multiple stocks of turbot in the Black Sea or that there is a single stock.

> Conclusion: Additional work is needed to compile and review available information that would provide a scientific basis for the stock structure of turbot in the Black Sea.

Finding: The assessment estimates that turbot SSB reached its peak in 1979 and then declined dramatically during the 1980s to half as large as it was during the 1950s and 60s. During the most recent seven years SSB declined steadily and reached its historic low in 2012. It is unkown if these changes in biomass occurred uniformly in all regions of the Black Sea.

> Conclusion: Given that the overall spawning biomass of turbot in the Black Sea is likely to be at very low levels (regardless of whether there are multiple stocks, or only one stock), it would be prudent to adopt a precautionary approach for managing Black Sea turbot, until such time that it can be established that there is more than one turbot stock and that the healthier stock(s) can be managed independently and without detriment to the weaker one(s).

Whiting

Finding: Whiting is a relatively short-lived demersal species and landings are predominately age-2 to age-3 fish, but large numbers of age-0 and age-1 fish are caught and discarded by non-target fisheries. Targeted fishing for whiting is done almost exclusively by Turkey. Most of the reported landings of whiting since 2003 were taken by Turkey (98%).

Finding: Discard of whiting, particularly of young fish (age-0 and age-1), appears to be a large but variable fraction of the annual catch of whiting in many of the national fisheries (other than those of Turkey), but the available sample data are patchy and there are major gaps in the sample record.

Conclusion: It was not possible to develop scientifically defensible estimates of the annual catches of age-0 and age-1 whiting in the Black Sea.

Finding: For the period 1994 to 2012 annual estimated catches of age-2 to age-6+ fish, after making SOP corrections, fluctuated around 7000 t with a low of 2159 t in 2005 and a peak of 16 980 t in 2010. Catch during 2012 (5868 t) is similar to the average catch during 1994-2002 but is the third consecutive year of decline. The removal of the first two age classes from the catches shifts the trend of the catch time series

Finding: The XSA method was applied to whiting catch-at-age information from 1994 to 2012 for age-classes 2 to 6+. During this period the SSB varied without any clear trend. The estimates of age-2 recruitment in this assessment do not account for the large but variable rates of fishing mortality experienced by each cohort during their first two years of life.

Conclusion: The EWG does not consider that the stock assessment for whiting in the Black Sea provides quantitative estimates of stock biomass or rates of fishing mortality that are valid for all age classes, but the Group does consider that the assessment results are valid indicators of trends in spawning biomass.

Finding: The assessment estimated that the fishing rate F(2-4) during 2012 was = 0.958, which greatly exceeds the F_{MSY} proxy, $F_{MSY}(1\text{-}4) \leq 0.4$,proposed by EWG 12-16 as the limit reference point consistent with high long term yields and low risk of stock collapse.

Conclusion: The EWG 13-12 classifies the stock of whiting in the Black Sea as being potentially exploited unsustainably.

Horse Mackerel

Finding: The Mediterranean horse mackerel is a moderately short-lived pelagic species and landings are predominately age-1 and age-2 fish, but appreciable numbers of age-6+ fish are sometimes caught. No discards of horse mackerel have been reported. Most of the reported landings of horse mackerel since 2003 were taken by Turkey (96%).

Finding: During the period assessed (2004 to 2012) annual catches of horse mackerel increased markedly from just under one thousand t to a peak of about 25 thousand t in 2012, but historically the reported landings of horse mackerel have been as high as 141 thousand t (in 1985).

Finding: A stock assessment was attempted using XSA applied to catch-at-age data for age-classes 0 to 5+ for the period 2004 to 2012 for the entire Black Sea. The XSA results produced unsatisfactory retrospective patterns and residual patterns, and were deemed to be unreliable.

Conclusion: The EWG does not endorse the results of the XSA analysis of horse mackerel.

Finding: The tuning fleet for the assessment, which was based on commercial CPUE data from Bulgaria, was considered unreliable and inappropriate for tuning the analysis because the bulk of the catches came from the Turkish fishery.

Conclusion: An international hydro-acoustic survey is needed to monitor trends in the horse mackerel age-structure and stock biomass across all national waters of the Black Sea.

Anchovy

Finding: Black Sea anchovy is a short-lived pelagic species and catches are predominately age-0 to age-1 fish. Most of the reported landings of anchovy since 2003 were taken by Turkey (90%). In the last two years, and particularly in 2012, a considerable portion of the anchovy catch was discarded at sea due to increased control of the minimum landing size at the landing sites. As most of the fish were discarded before being transferred into the seiners, the discard amounts could only be guessed by comparing size frequency distributions of landed anchovies with those sampled during the pelagic surveys carried out at the same time and in the same area. The EWG did not consider the status of the Azov Sea anchovy, which is considered to be a separate stock from the Black Sea anchovy and is harvested almost exclusively by the Russian Federation.

Finding: During 1988 to 2012the annual catches of anchovy varied from about 129 thousand tons to 386 thousand, with no particular trend except for a 6-year period of steady increase during 1990 to 1995. The landings during 2012 were 186 thousand t and higher than in 2011, but historically the reported annual landings of Black Sea anchovy have been as high as 392.6 thousand t (in 1988).

Finding: The stock assessment methods XSA and sVPA were applied to Black Sea anchovy catch-at-age data for age-classes 0 to 4+ from the period 1988 to 2012 for the entire Black Sea. The ASPIC surplus production method was also applied to catch and effort data for the same period.

Finding: Despite the assessment uncertainties, there was a noticeable increase in the recruitment during recent years. The increase is particularly striking in the 2012-13 samples.

Finding: The age-structured XSA and SVPA methods produced very some large residuals and poor retrospective patterns. The APSIC results were in conflict with the age-structured models.

Conclusion: The EWG does not endorse the results of any of the assessments for anchovy.

Finding: The available acoustic survey data,which are crucially important for the reliability of the assessment results, are limited to the past two or three years. The results from the surveys could not be used in the assessments.

Conclusion: Turkey should be strongly encouraged to continue its program of conducting routine acoustic surveys of the anchovy stock.

Piked Dogfish

Finding: Piked dogfish is a pelagic species that is long-lived, late maturing, and has low fecundity, which means that the stock probably has very limited capability to rebound quickly once it becomes depleted. Significant quantities of dogfish may have been discarded or caught illegally, but the magnitude remains un-quantified. Most of the reported landings of dogfish since 2003 were taken by Turkey (44%).

Finding: The reported landings of piked dogfish have dropped steadily and dramatically since the start of the landings series, from more than 6000 t in 1989 to only 70 t in 2012.

Finding: The VIT program was applied to catch-at-age matrices for 1989-2012 that were based on length compositions and age/length keys from Ukrainian and Romanian samples and the assumptions M = 0.15 and terminal F = 0.15. The program YPR-LEN was used for obtaining reference points. The fishing mortality rate during 2012 was estimated to be 0.239, above the $F_{0.1} = 0.177$ proxy for F_{MSY}.

Conclusion: Because results from the analyses depend heavily on assumptions of unknown validity, the EWG viewsthe results as being uncertain but indicative of the possible status of piked dogfish.The EWG cannot estimate a TAC constraint for 2013, but considers the stock to be overexploited and suggests that directed fishing effort and/or catches should be reduced.

Red Mullet

Finding: Red mullet is a moderately short-lived demersal species and catches are predominately age-1 and age-2 fish. No information on the discards of red mullet was provided to the Working Group. Most of the reported landings of red mullet since 2003 were taken by Turkey (77%).

Finding: For the period assessed, 1990 to 2012, there was a general decline in the annual catches from about 2500 t to 700 t.

Finding: TheXSA method was applied to red mullet catch-at-age information from 1904 to 2012 for age-classes 0 to 6+. During the 1990s the SSB was in the range of 5000 - 6000 t, whereas in the recent years it dropped to about 1500-2000 t, and is estimated as being 1289 tin 2012.Fishing mortality has been consistently high since 1990 (0.8 to 1.0), well above the $F_{0.1}$ proxy for F_{MSY} (0.46).

> Conclusion: The EWG endorses the stock assessment for red mullet and considers that the stock was exploited unsustainably in recent years. The catch forecast for 2014 based on the F_{MSY} proxy is 467 t, which is less than the catch forecast under status quo fishing.

Finding: The assessment assumes that red mullet in the Black Sea form a unit stock, but the scientific basis for this assumption has not been established.

> Conclusion: Genetic, morphometric and life-history studies on red mullet in the Black Sea are needed to identify possible stock boundaries.

Finding: The current assessment only has a single tuning index (based on Turkish data) and trends in that index may not be representative of trends in other regions where the stock occurs and is fished.

> Conclusion: Additional tuning series are needed for red mullet.

Bonito

Finding: Atlantic bonito is a short-lived pelagic species (max reported age is about 5 years) and the stock in the Black Sea has not previously been assessed. Essentially all of the reported bonito landings in the Black Sea were taken by Turkey. No discard data for bonito were available.

Finding: During 1982 to 2012 the average reported landings of bonito were large, 12 322 t, and quite variable, ranging from 2603 t in 1984 to 63 952 t in 2005.

Finding: The EWG was unable to develop a quantitative assessment for this stock.

Finding: In the available length frequency data, from samples collected from the Eastern Black Sea, almost all the fish were relatively small (< 50 cm) and there were very few large mature individuals, which implies that the adult portion of thebonito population may not reside in the Black Sea or may be unavailable to fishing operations in the Black Sea

> Conclusion: Ichthyoplankton samples from oceanographic surveys should be explored for evidence that bonito spawn in the Black Sea and to identify spawning seasons and locations.

Finding: The EWG assembled information on the length frequency of the Turkish landings of bonito and developed growth curves. However, the age determinations that underlie the growth curve estimates remain highly uncertain, particularly for the older fish, because of the scarcity of large fish..

> Conclusion: Turkey should be encouraged to continue sampling its landings of bonito at a fine temporal scale (e.g., monthly) to provide a base of information that will clarify the growth of bonito and the relative strength of recruiting cohorts.

Rapa Whelk

Finding: Rapa whelk is an invasive mollusc that was introduced to the Black Sea in the 1940s. The stock in the Black Sea has not been assessed. Most of the reported landings of rapana since 2003 were taken by Turkey (76%).

Finding: Black Sea landings of rapana reached their peak level of almost 18 thousand tons in 2006, and landings during 2012 were slightly more than 13 thousand tons.

Finding: The EWG compiled and examined the available length composition data with respect to their suitability to provide estimates of growth and age composition. It was not possible to distinguish clear indications of cohorts in length compositions tabulated on a monthly or annual basis.

Conclusion: Age determination of rapa whelk is an important technical problem and region-wide harmonization of methods for ageing would be very beneficial for comparative studies of rapana.

Finding: The Turkish length composition data were converted to length at age data using the Ukrainian age-length key, but the results were considered to be unreliable because the Ukrainian rapana, which ranged in shell length from about 40 to 105 mm, were much larger than the Turkish rapana, which ranged in shell length from about 20 to 95 mm.

Finding: The size compositions of the Turkish samples of rapana were markedly smaller than the size compositions of the Ukrainian samples, which is probably due to much higher rates of exploitation of rapana in Turkish waters.

Finding: The EWG was unable to develop a quantitative assessment for this stock.

Finding: Rapa whelk remains a data poor stock in the Black Sea.

Conclusion: All countries should include rapa whelk in their data collection programs.

3 FOLLOW-UP ITEMS

The text below highlights some issues that arose during the EWG 31-12 meeting that created difficulties for the meeting or the process of completing the report. The EWG offers the following suggestions for next year to improve the process for preparing assessments of the Black Sea stocks.

- To facilitate activities of the Black Sea EWG at its next meeting, there should be discussions prior to the meeting that lead to the development of agreed and documented procedures for compiling the stock assessment data and developing the catch-at-age matrices.
- Prior to the next meeting of the Black Sea EWG there should be discussions leading to the development of agreed standard formats for presenting the stock assessment data and results, so that they are more easily accessed and understood by readers of the EWG Report.
- Stock coordinators, for all species but especially for turbot, should compile and review available information that would provide a scientific basis for the stock structure in the Black Sea.
- The next assessment of whiting should explore alternative approaches for estimating discards of whiting (e.g., developing whiting discards rates relative to the landed catch of sprat).
- The next assessment of anchovy should explore the possibility of developing a longer time series of catch and effort data to use in an ASPIC surplus production model.
- The next assessment of Atlantic bonito should:
    - examine data from neighbouring geographic regions because this might produce a better understanding of bonito migration patterns;
    - examine available biological samples from oceanographic surveys to determine if they provide evidence of bonito eggs or larvae; and
    - compile data on fishing effort directed at bonito.
- The next assessment of rapana should explore the possibility of using records of exported meat weights as a source of information.

4 INTRODUCTION

The STECF Expert Working Group EWG 13-12 meeting was held during 30 September to 4 October 2013 in Ispra, Italy. The chairman called the group to order at 9 am on 30September 2013, and adjourned the meeting at4 pm on 4 October 2013. The meeting was attended by 14 experts from Bulgaria (4), Romania (2), Sweden (1), Turkey (5), Ukraine (2), under the lead of the chairman from USA. One focal person from DG MARE and three experts from JRC also attended the meeting.

The present report of the EWG 13-12 is divided into two main parts. The first part presents a summary of the EWG's findings and conclusions, and short summary sheets for each of the nine stocks. Each summary sheet includes the main assessment results on trends in the fishery and stock, and estimates of biological reference points. The second part presents all the details of the stock assessments, as well as descriptions of the assessment methods applied.

4.1 Terms of Reference for EWG-13-12

Background

The European Union adopted for the first time in 2008 and then for subsequent years catch limitations and associated technical measures for sprat and turbot fisheries in the Black Sea. Those measures were adopted in the light of scientific advice provided by STECF.

Last year, the STECF Experts Working Group for the Black Sea met in Ispra (Italy) with the objective, among others, of assessing the state of the main stocks in the Black Sea Region. Relevant data were compiled and stock assessments for the following 7 species were undertaken: sprat, turbot, anchovy, whiting, horse mackerel, piked dogfish, and red mullet. As an outcome of this meeting, STECF underlined that, assessments were compromised by the paucity of fishery independent survey data. Moreover it was underlined that in the absence of fishery independent estimates of recruitment, the results of short term catch predictions were also uncertain.

Four of the stock assessments undertaken, sprat, turbot, anchovy and whiting, were of sufficientquality to provide analytical estimates of recent exploitation rates and stock status in relation toproposed biological reference points. Although the assessments for sprat, anchovy and whiting are considered sufficiently reliable to be used as a basis for short-term catch forecasts, the assessment results for for turbot are less reliable and are indicative of relative trends only.

Regarding other relevant stocks, the assessments for Mediterranean horse-mackerel and for red mullet were considered as being indicative of trends only, while for Picked dogfish the results of the assessment were inconclusive with respect to stock status. The available information for Rape Whelk was considered insufficient to perform the relevant assessment.

In the light of the above, STECF reviewed gaps in current knowledge and data. The low quality of the input data for assessment (in terms of age and size composition, fishing effort, CPUE and research surveys) was recognised as being the most pressing problem. STECF draw the attention of the Commission on the negative effect that the lack of quality survey information has on the estimation of population parameters and in the reliability of the assessments.

Other identified gaps that need to be addressed in the near future include:

- Insufficient knowledge of stock units
- Lack of knowledge, evaluations and monitoring programs for assessing the IUU and discards
- Lack of reliable frameworks of assessing and standardising of the commercial fleets fishing effort and CPUE

As a final recommendation for the 2013 exercise, STECF suggested that the state of data concerning Atlantic Bonito (Sarda sarda) in the Black Sea be explored in order to evaluate the possibility to assess this stock.

With a view to improve and update the assessments and catch forecast compatible with high yields and low risk of stock depletion (i.e. MSY perspective), of the concerned stocks and fisheries in the area, which will be the basis for further management measures STECF is requested to provide scientific advice on the exploitation levels (i.e. fishing mortalities or alike) and present status and recent development of stocks and the marine ecosystem of the Black Sea and evaluate the existing measures.

With a view to facilitate transfer of knowledge and expertise to the regional multilateral body, it is particularly relevant that to this meeting the GFCM Secretariat will be invited. The results of this meeting will provide valuable information as a basis for further joint analysis and discussions in future GFCM Assessment Working Groups. All these sources of information will provide GFCM-SAC with valuable elements for its scientific deliberations and advice.

It is particularly appreciated the participation in STECF work of scientists from non-EU countries (Turkey, Ukraine and Russian Federation), that will allow a strengthen cooperation namely for the assessment of shared stocks.

This is another step toward a deeper cooperation on fisheries related matters amongst Black Sea scientists which will help feeding coastal states' reflections on the direction ahead to improve fisheries management and governance at multilateral level in the Black Sea Region and in the framework of GFCM.

Terms of Reference

Without prejudice, STECF is requested to advice in particular on 2014 catch forecasts compatible with high yields and lower risk of stock depletion as well as on the state of the most relevant exploited stocks with a view to inform management choices, including technical measures, in line with EU policy objectives and principles for sustainable fisheries management for the stocks listed in Annex I, in line with a MSY perspective.

EWG 13-12 is requested to address the following ToR for Black Sea stocks:

- Compile and provide complete sets of national annual data on landings, discards, landings at age, discards at age, mean weight at age in the landings, mean weight at age in the discards, maturity ogives at age and natural mortality at age by area for the longest time series available up to and including 2012. The data should be compiled based on official data bases, best expert knowledge and by using the results of scientific surveys.
- Compile and provide all fishery independent data (pelagic, demersal, hydro-acoustic surveys) for the stocks as available, their juveniles, eggs or early life stages. In order to allow the use of such data to potentially calibrate virtual population analyses, the abundance, biomass and spawning stock biomass indices at age should be compiled for the longest time series available up to and including 2012.
- Compile and provide complete sets of annual fishing effort data (number of vessels, kW*days, GT*days, fished hours) by nation, for fleets and gears (by mesh size where applicable), and area for the longest time series available up to and including 2012.
- Assess trends in historic stock parameters for the longest time series available up to and including 2012 (fishing mortality at age) and up to and including 2012 (spawning stock biomass, stock biomass, recruits at age). Different assessment models should be applied as appropriate, including analyses of retrospective effects.
- Propose and evaluate candidate limit and precautionary reference points consistent with maximum sustainable yield and precautionary approach;
- Review and evaluate existing fisheries management measures and comment about their adequacy to ensure sustainable exploitation of stocks while delivering higher yields and low risk of stock depletion;

- Predict spawning stock biomass, stock biomass, recruits and catches at age and in weight in, 2013, 2014 and the beginning of 2015 under different management scenarios including the status quo fishing (mean F at age 2008-2012, rescaled to 2012) and with a TAC constraint for 2013. Specifically comment on the consequences for the listed stock parameters with regard to reference points consistent with maximum sustainable yield;
- Up-date the description of EU fisheries exploiting these stocks, in terms of fleets, fishing gears, deployed fishing effort (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality;
- Identify knowledge and monitoring gaps for fisheries, stocks, vital fish habitats and other environmental aspects relevant to fisheries in the area and provide information on the reasons for this deficiency and suggest monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps;
- Evaluate the progress made in addressing such gaps since last year;
- Prepare and/or up-date maps showing geographic density patterns in annual abundance indices derived from surveys aggregated for age groups selected by the fisheries and compare them with maps of geographical distribution patterns in annual landings and discards of the stocks listed in Annex I by fishing gear;
- Identify other important fisheries and stocks that may be in need of specific management measures to ensure sustainable exploitation and analyse whether the scientific basis is adequate or needs to be further developed;
- Report all results to the STECF Plenary in November 2012 for further scrutiny and endorsement.

Annex I: ***List of stocks to be assessed***

Species common name	**Species scientific name**	**FAO CODE**
Sprat	*Sprattus sprattus*	SPR
Turbot	*Psetta maxima*	TUR
Whiting	*Merlangius merlangus*	WHG
Anchovy	*Engraulis encrasicolus*	ANE
Mediterranean horse mackerel	*Trachurus mediterraneus*	HMM
Horse mackerel	*Trachurus trachurus*	HOM
Red mullet	*Mullus barbatus*	MUT
Striped red mullet	*Mullus surmuletus*	MUR
Piked dogfish	*Squalus acanthias*	DGS
Rapa Whelk	*Rapana venosa*	RPW
Atlantic Bonito	*Sarda sarda*	BON

In support of its advice STECF shall provide for each stock:

a) A full methodological description of the assessment and advisory procedure updated whenever a significant change is made;

b) Estimates of landings, fishing mortality, recruitment and spawning stock together with information or estimates of the uncertainty with which these parameters are estimated;

In addition, STECF is requested to critically analyse the current state of implementation of surveys in the Black Sea including, where relevant, suggestions to improve their performance in terms of sampling protocols, target species, data gathering, biological parameters estimates and spatio-temporal distribution of the survey effort.

4.2 Participants

The full list of participants at the STECF EWG-13-12 is presented in Appendix 2. Antonio Cervantes the focal person from DG Mare attended all sessions of the Working Group.

5 SUMMARY SHEETS

The stock-specific summary sheets in the following section provide short summaries and scientific findings on stock status and fisheries management. These short summaries include the main results of the analytical assessment of stock status and biological reference points, if such results could be produced using the available data. The full description of the data and methods can be found in section 6,which provides the detailed assessments.

5.1 Summary sheet forSprat (*Sprattus sprattus*) in GSA 29

Species common name:	Sprat
Species scientific name	*Sprattus sprattus*
Geographical Sub-area(s) GSA(s):	GSA 29

Description of the Fisheries

The sprat fishery takes place in the Black Sea (GFCM Fishing Sub-area 37.4 (Division 37.4.2) and Geographical Sub-area (GSA) 29). In Bulgarian, Romanian, Russian and Ukrainian waters the most intensive fisheries for Black Sea sprat are conducted in April to October with mid-water trawls on vessels 15- 40 m long and a small number vessels greater than 40m.The main fishing gear is midwater trawl and the mesh size of the codend is 6.5-7 mm.Harvesting of Black Sea sprat is conducted during the day when the sprat aggregations become denser and are successfully fished with mid-water trawls. Other fishing gears targeting sprat are beach seines and uncovered pound nets.

Available Fishery-Dependent Data

Landings data were provided by Bulgaria, Romania, Ukraine, Turkey and the Russian Federation based on official national statistics. No data from Georgia were available. Bulgaria provided also landings data based on expert judgement for 1992 – 2011. Landings-at-age, landings-weights-at-age and fishing effort were provided by Romania through the Data Collection Program (DCR199/2000 EC), whereas Bulgarian data on sprat were provided through other sources. Discards are reported only for Romania for the 2011 and 2012 as they were very low. There were no maturity estimations reportedin 2012.

The data are believed to be of sufficient quality to conduct an assessment for sprat in the Black Sea.

The complete set of fishery-dependent data is presented in the detailed assessment (6.1.2).

Table of sprat landings (tons) in the Black Sea.

	Bulgaria	*Bulgaria	Romania	Ukraine	Turkey	Georgia	Russian Federation	Total
1980	16568		989	47635	0	4571	14687	84450
1981	1888		2283	49175	0	5781	20165	79292
1982	16524		3004	3862	0	2462	15266	41118
1983	12023		3406	20755	0	886	3843	40913
1984	13921		4456	18021	0	847	5270	42515
1985	15924		6836	23657	0	1817	3365	51599
1986	1169		8979	33147	0	2939	7010	53244
1987	10979		9474	43158	0	697	8972	73280
1988	6199		6454	39835	0	7172	7157	66817
1989	7403		8911	63239	0	9708	16045	105306
1990	2651		3198	33174	0	6895	6955	52873
1991	1909		729	11094	0	2313	2675	17082
1992	2353	3266	2074	11492	0	830	3221	20883
1993	2174	3705	2439	9154	640	32	694	16664
1994	2200	3500	2203	12615	700	308	1013	20339
1995	2874	3200	1982	15218	157	288	1263	22108
1996	3535	3500	2014	20720	937	185	1537	28893
1997	3646	3646	3318	20208	468	85	706	28431
1998	3275	3275	3293	30282	1236	24	1243	39353

1999	3595	3595	1933	29238	421	45	4473	39705
2000	1737	3500	1803	32644	6225	42	5543	49757
2001	695	6961	1792	48938	1008	40	11122	69861
2002	11595	11595	1617	45430	1965	34	11218	71859
2003	9155	9155	1219	31366	5775	2	204	47721
2004	2889	7997	135	30891	5186	12	143	44364
2005	2575	6500	1487	35707	5271	19	1316	50300
2006	2655	8183	492	21308	6681		8157	44821
2007	2559	2985	208	18013	11725		6077	39008
2008	4304	4304	234	21111	39903		7814	73366
2009	4551	4551	92	24603	53385		8744	91375
2010	4041	4041	39	24652	57023		5839	91594
2011	3958	3958	131	24379	87141		5099	120708
2012	3157		88	15751	12092		3937	35025

* based on expert judgement

The total landings dropped significantly in 2012 from 120 708 to 35 025 tons. The decrease was observed in all Black Sea countries for which data were available.

Available Fishery-Independent Data

The data in 2012 regarding geographical distribution were obtained from a pelagic survey conducted in Romanian waters of the Black Sea during autumn.

To estimate the biomass of the main agglomerations of fish species with commercial value, the trawl survey was executed in waters of the Romanian continental shelf and used data obtained from industrial trawlers. The evaluation of the sprat stock (dense fish shoals) was made using the swept area method. The 33 trawlers that participated surveyed an area of 2 855.8 Nm^2. The average values of the sprat catches were between 19.72 t/Nm^2 and 21.37 t/Nm^2. Significant catches were recorded between 30 and 60 m isobaths, in the region of Periboina - St. Gheorghe and Constanta - Mangalia. The autumn survey coveredan area of 2 855.7 Nm^2, and sprat biomass was estimated at 68 887 tons.

In Turkish waters the mean catches per unit effort (CPUE) and the abundance index (CPUA) were estimated respectively as 1289.59 kg/km^2 and 1101.54 $kg/km^2$from trawl sampling conducted between 40-80 m (minimum 32.8 m, maximum 109.8 m) depths along the Samsun shelf area during the period January and May 2012. Abundance indices were estimated by the ‘swept area method’ for the period of the sprat fishing seasons (January-May) from commercial vessels (Sparre and Venema, 1992). The individual experience of fisherman and the quality of technical equipment on the vessel are factors influencing the amount of daily catch. The sprat catch reaches its maximum value in the spring, especially between March-May. Both the CPUE and CPUA indices showed similar declines between 2011 and 2012. The mean values were 4437.75 kg/km^2(CPUE) and 4184.85 kg/km^2(CPUA) in 2011. Comparingthe two last years, the 2011 indices are about 3.5 times higherthan the 2012 indices.

The biomass estimations from scientific surveys using Swept area and hydro acoustic methods in EU waters of the Black Sea for 2008-2012 are presented as follows:

Biomass, t	2008	2009	2010	2011	2012
Bulgarian waters	32 718.3	41 761.4	75 080.2	48 201.7	-
Romanian waters	60 000	60 000	59 600	-	68 886

The pelagic trawl surveys were based on the “swept area” methodology and stratified random sampling in the areas. Hauls with different duration were conducted within these areas according to the defined “strata” (from 15-100 m depths). The maps provided in the report reflect the swept area method applied in Romanian and Turkish waters in 2012. The survey in Romanian waters was done under Data Collection Program (DCR199/2000 EC) and the survey in Turkey was conducted under a national research program in the Samsun area. In Romanian waters the number of hauls was 32 and in Turkey the total number of hauls in the Samsun area was 126.

Maps showing results of the pelagic surveys conducted during 2012 are presented in the detailed assessment (6.1.3)

Fishing Effort

In Bulgaria in 2012 there were active vessels using otter trawl (OTM), with effort estimated at 17 510 thousand GT days at sea.Engine power ranged between 140 HP and 970 HP, with a mean of about 415.7 HP.In Romanian waters there were 13 active fishing vessels,generating effort of 26 167GT days at sea. Most of the reported sprat catches for 2012 in Romanian waters were made by uncovered pound nets. The Ukraine sprat fishing was carried out by 16 fishing vessels from March to October 2012. Pelagic trawl vessels operating in Turkish waters are generally 18-30 m in length. Though the number of vessels licensed for the pelagic fishery totals 120, only 64 of them actively operated during the 2011/12 fishing period. In contrast,there were 82 active vessels in the previous fishing period. The smallest of these licensed vessels was 14.9 m, the biggest was 32.2 m, and the mean length was estimated at 22.7 m LOA. In contrast, in the previous fishing period there were 82 active vessels.

The compiled fishing effort data are presented in the Detailed Assessment (6.1).

Stock Assessment Summary

The stock was assessed using the Integrated Catch Analysis method applied to catch-at-age data from 1993 to 2012. During this period there were large changes in the catch, which increased steadily from a low level of about 17 thousand tons in 1993 to a first peak level of about 72 thousand tons in 2002, and a subsequent peak of almost 121 thousand tons in 2011. The series of spawning biomass estimates also had two peak values, but they occurred in 2001 and 2009, and both peaks were about 500 thousand tons. The series of recruitment estimates similarly had two peaks, of similar size, but in 1999 and 2008.

- State of the adult abundance and biomass (SSB):

According to the present assessment, the SSB in recent years ranged at medium to high levels(between 200 000 and 500 000 t). In 2012 the SSB dropped to 228 000 t. Under a constant recruitment scenario and *status quo* F = 0.404, in2013 the SSB is expected to increase to 268 750 and after to slightly increase up to 289 667 t by 2015.Since no precautionary level for the stock size of sprat in GSA 29 was proposed, EWG 13-12 cannot fully evaluate the stock status in relation to the precautionary approach.

- State of the juveniles (recruits):

Recruitmentwas estimated to be increasing up to 2008, and since then has followed a decreasing trend. Recruitment estimates are rather imprecise due to the lack of survey data. The most recent recruitment value is estimated as the geometric mean over 2009-2012.

- State of exploitation:

In recent years the fishing mortality peaked in 2010-2011 at levels of 0.75 - 1.12. Based on a limit reference exploitation rate of $E \leq 0.4$,which equals F = 0.64 (the F_{MSY} proxy), the EWG considers that the stock of spratwas exploited unsustainably during those years. However, the current F = 0.404, whichequals an exploitation rate of E = 0.298 (natural mortality M = 0.95), has resulted in a three-fold drop in total catch in 2012 compared to 2011.*Status quo* fishing during 2013 – 2015 implies catches in the range of 39 907 to 45 504 t, which are below the recommended (F_{MSY}) catch of 64 544 t,

- Source of data and methods:

International landings data at age were constructed and the Integrated Catch Analysis (ICA) assessment method was applied. Discards of sprat are believed to be low, but the fishery for sprat is thought to produce appreciable (but unquantified) amounts of discards of other species (e.g., whiting). Short term predictionswere based on a short term geometric average recruitment.

The complete stock assessment results are presented in the Detailed Assessment (6.1).

Existing management measures

Catch quotasfor EU waters of the Black Sea were allocated as follows for 2011 and 2012: 8 032.5 t to Bulgaria and 3 442.49 t to Romania. No fishery management agreement exists among the other Black Sea countries. Turkey has adopted several kinds of regulation for its sprat fisheries: regulations about fishing areas, fishing gear, fishing seasons, and depth restrictions Ukraine had a TAC for sprat in 2012 of 70 000 tons. No information was available for management of sprat fishing in Russian Federation or Georgian waters.

Details about the management measures and regulations are provided in the Detailed Assessment (6.1).

Short and medium term scenarios:

A short term prediction of stock size and catches assuming a sustainable status quo fishing scenario has been provided together with a range of management options. Considering the short life span of sprat in the Black Sea and the high variation in estimated recruitment,the EWG 13-12 emphasises that the short term projections were based on the geometric mean of recent recruitment and the resulting catch projection is subject to high uncertainty. The poor knowledge about the recruitment dynamics prevented the formulation of medium term projections.

The status quo fishing in 2013, with F(1-3) = 0.4045, would result in landings of 39 907 t and SSB of 268 750 t. Thus the 2013 SSB is forecast to increase by about 18% compared to 2012 and total catch is forecast to increase by about 14%. With fishing at F_{MSY}= 0.64 (corresponding to an exploitation rate of 0.4) forecast catches are 64 544 t in 2014 and 56 596 in 2015, and SSB is forecast to decline.

The complete stock assessment projections are presented in the Detailed Assessment (6.1).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-16.

E (mean)	≤ 0.4

Table of limit and precautionary management reference points agreed by fisheries managers.

F_{msy} (age range)=	none
B_{pa} (B_{lim}. spawning stock)=	none

Comments on the assessment

Data and Information Gaps

The EWG 13-12 suggests that an international hydro-acoustic survey is needed to monitor the condition of sprat across all waters of the Black Sea, including the national waters of Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine.

There is concern that the fishery for sprat produces significant quantities of bycatch and discard of other fish species (e.g., whiting). The EWG suggests that there should be increased sampling of the sprat fishery by at-sea observers to quantify the amount of bycatch and discarding.

Progress since last Year in Addressing Gaps

The EWG report last year also suggested that an international survey was needed for the entire Black Sea region. There was no progress during the past year to develop such a survey.

5.2 Summary sheet for Turbot (*Psetta maxima*/*Scophthalmus maximus*) in GSA 29

Species common name:	Black Sea Turbot
Species scientific name	*Psetta maxima*/*Scophthalmus maximus*
Geographical Sub-area(s) GSA(s):	GSA 29

Description of the Fisheries

Turbot in the Black Sea during 2012 were exploited by all coastal states by stationary (bottom set gillnets, GNS) and mobile fishing gears. In Bulgaria, the total number of approved vessels involved in turbot fishery is 379, with Gross Tonnage between 0.35 and 117.36. In Romania, 66 vessels are involved in the turbot gillnet fishery, with a total of 1577 fishing days. In the Turkish area there were 362 vessels, using both gillnets and bottom trawls, involved in turbot fishery. For the rest of the countries, no data were available for the fishing fleets operating on turbot.

Available Fishery-Dependent Data

Landings, landings-at-age, landings-weights-at-age and fishing effort for Romania were reported through the EU Data Collection Program. Bulgaria reported only landings and fishing effort through the EU Data Collection Program. The landings-at-age and landings-weights-at-age for Bulgaria were provided from other sources. Landings data for Turkey, Ukraine and Russia were provided from the official statistics of each country.

International landings-at-age data are believed to be underestimates due to the occurrence of illegal, unregulated and unreported (IUU) catches. However, discards are considered to be negligible. For the assessment it was assumed that the IUU catches of turbot during 2002-2010 were a proportion of the Turkish catch during 1993-2001 and 2009-2010, and these amounts were then added to the officially reported catch. The IUU catch during 2012 was estimated based on the average proportion during 2002-2009. The available data from fisheries dependent sources are considered good enough to perform a reliable stock assessment.

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.2.4).

Landings and landings plus IUU estimates of turbot in the Black Sea during the period 1989 – 2012.

Year	Bulgaria	Romania	Ukraine west	Ukraine east	Turkey west	Turkey east	Russian Federation	Georgia	Black Sea total	IUU Estimated
1989	0.9	0	2	0	448	1001	0	8	1459.9	
1990	0	0	9	0	908	475	0	1	1393	
1991	0	2	17.1	0.9	600	315	0	0	935	
1992	0	1	18	1	308	110	1	0	439	
1993	0	6	10	0	400	1185	2	0	1603	
1994	0	6	18	1	1293	821	5	0	2144	
1995	60	4	10	0	2006	844	19	0	2943	
1996	62	6	37	2	1414	510	17	0	2048	
1997	60	1	40	2	777	134	11	0	1025	
1998	64	0	40	2	1056	412	14	0	1588	
1999	54	2	69	4	1579	225	15	5	1953	
2000	55.1	2	76	4	2321	318	4	9	2789.1	
2001	56.5	13	123	6	2169	154	24	11	2556.5	
2002	135.5	16.7	99	5.5	193	142	15	11	617.7	1411.6
2003	40.8	24.0	118	5.9	126	93	15	1	423.7	942.7

2004	16.2	42.0	126	7.2	118	116	1.7	7	434.1	988.7
2005	12.7	36.5	123	6	273	275	7.5	7	740.7	2039.5
2006	14.8	35.1	154	8	266	481	7.6	0	966.5	2736.9
2007	66.9	48.0	205	10.6	346	353	5.7	0	1035.4	2692.0
2008	54.6	47.1	239	12.4	224	234	4.7	0	815.8	1901.3
2009	52.5	48.8	247	16	223	119	24.3	0	730.5	1541.1
2010	46.5	48.3	166	41	218	77.0	25	0	621.7	1321.0
2011	37.8	43.3	211	25	108.1	36.4	24.1	0.00	485.6	886.8
2012	36.44	43.2	223	17.9	172.2	0	35.3	0	528.0	963.4

Available Fishery-Independent Data

Three national surveys were executed during 2012 and data were provided for assessing the stock. These surveys, which were reported through the EU Data collection Framework program, cover the Bulgarian and Romanian sectors of the Black Sea and one survey covers the Turkish coast.

The compiled fishery-independent data are presented in the Detailed Assessment (6.2.4).

The estimated biomass and biomass indices during the surveys were mapped and are presented in the Detailed Assessment (6.2.3)

Fishing Effort

The compiled fishing effort data are presented in the Detailed Assessment (6.2.1.3).

The total CPUE of Bulgaria for 2012 is estimated at 263.19, which is higher, compared to 2011 (255.69). The bulk of the effort is concentrated within the fleet segments LOA 18 – 24 m (26.55%) and 24 - 40 m (39.74 %). In Romania, 66 vessels were involved in the turbot gillnet fishery, with total effort of 1577 fishing days.

Stock Assessment Summary

To prepare the stock assessment for turbot the EWG assumed that all turbot in the Black Sea are part of a single stock, but it should be noted that not all members of the Working Group agreed that this assumption was valid or appropriate. The Group was not provided with strong evidence either that there are multiple stocks of turbot in the Black Sea or that there is a single stock. For the sake of parsimony, and because the available fishery data are not sufficient to develop catch-at-age matrices at small geographic scales, the available data were combined to produce a single catch-at-age matrix that represents turbot across the entire Black Sea.

The stock assessment was conducted using the State-space Assessment Model (SAM), as was done by the EWG in 2012. The model was applied to catch-at-age data for age-classes 2 to 10+ from the period 1950 to 2012. During this period annual catches of turbot have dropped from an average of about 4000 t during the 1950s and 1960s to an average of about 2000 t during the 1990s and 2000s. Except for a slight increase in catch in 2012, the annual catches have declined steadily since 2006.

- State of the adult abundance and biomass (SSB):

Survey indices and the SAM analyses indicate that the stock size is currently at a historic low (around 1100 t) and it is around one third of the estimated Blim (2914 t). The F value estimated for 2012 (0.85) is more than three times higher than F_{MSY} (0.26).

- State of the juveniles (recruits):

Recruitment has decreased since 2003 and the recruitment values estimated for the most recent set of cohorts (born between 2006-2010) are among the lowest observed in the time series.

- State of exploitation:

The STECF EWG 13-12 proposes that Fmsy for this stock (i.e. F which maximizes average catches in the long run) is 0.26 per year and should be set as a limit reference point consistent with achieving high long term yields.

Currently F is around the historical high level at 0.85, more than three times F_{MSY}. The EWG 13-12 classifies the stock of turbot in the Black Sea as being exploited unsustainably and at risk of collapse. The EWG notes that the fishing mortality remains at high level with no sign of reduction, despite the recently low TACs. The EWG considers that on precautionary grounds there should be no directed fishing for Black Sea turbot and that by-catch should be minimized.

The assessment, which covers the period 1950-2012, estimates that SSB reached its peak in 1979 and then declined dramatically during the 1980s to half as large as it was during the 1950s and 60s. During the most recent seven years SSB has declined steadily and it reached its historic low in 2012. It is unknowif these changes in biomass occurred uniformly in all regions of the Black Sea. However, given that the overall spawning biomass of turbot in the Black Sea is likely to be at very low levels (regardless of whether there are multiple stocks, or only one stock), it would be prudent to adopt a precautionary approach for managing Black Sea turbot, until such time that it can be established that there is more than one turbot stock and that the healthier stock(s) can be managed independently and without detriment to the weaker one(s).

- Source of data and methods:

The data set for the period 1950-2012 were compiled from historical data sources and new data for 2012. Available data, consisting of total landings, catches at age, weights and maturity at age, were considered appropriate for assessing the stock using the State-space Assessment Model (SAM) (Nielsen et al., 2012). All assessment runs were performed using version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore). Five tuning series (four surveys and one commercial CPUE series) were compiled from previous assessments and recent data. In 2012, a new survey fleet for the Eastern Ukrainian Black Sea area was added to the existing survey fleets of Bulgaria, Romania, Western Ukrainian area and Turkish commercial CPUE.

The complete stock assessment results are presented in the Detailed Assessment section (6.2.4).

Existing management measures

Turbot fisheries in Black Sea EU waters have been managed since 2008 through the annual establishment of fishing opportunities (EU quotas), by the adoption of Council Regulations. During the last three years, the EU turbot quota has been fixed at 86.4 t and allocated to Bulgaria and Romania (50 % each), although the scientific advice from STECF in 2011 and 2012 was that there be no directed fisheries and that by-catch should be minimized. The same Council Regulations set up every year the prohibition of fishing activities during the turbot spawning period, in force from 15 April to 15 June in European Community waters of the Black Sea. It should be noted that the same period of prohibition is fixed by Turkish National Legislation.

During the 37th Session of the General Fisheries Commission for the Mediterranean (GFCM), a recommendation was adopted to establish a set of minimum standards for turbot fisheries in the Black Sea. This recommendation established a minimum conservation size (45 cm) for turbot and a minimum mesh size (400 mm) for gillnets. It should be noted that these measures were already in place in Turkey and the EU.

At the national level, different technical or management measures are in force in Bulgaria, Romania, Turkey and Ukraine.

A complete description of management measures is presented in the Detailed Assessment (6.1.1.2).

Short and medium term scenarios:

The STECF EWG 13-12 made qualitative assumptions about the IUU (Illegal, Unregulated and Unreported) fishing of turbot and estimated the Potential Unreported Catch in 2012. The estimates are considered to reflect the actual level of misreported catches of turbot in the Black Sea.

However, given the current estimate of stock status (F is more than three times higher than F_{MSY} and the SSB is about one third of the estimated Blim) the STECF EWG 13-12 did not undertake making short and medium term catch projections for this stock.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-12

Fmsy[1] =	0.26
Bpa[2]	4080
Blim[3]	2914

Table of limit and precautionary management reference points agreed by fisheries managers

Fmsy (age range)=	None
Bpa (Blim, spawning stock)=	None

[1]Derived from simulations; [2] Estimated as 39% of the maximum obsrebed biomass; [3] Bpa=1.4*Blim

Comments on the assessment

Data and Information Gaps

The main gaps in the fishery dependant data sets are related to the quality of the official landings and effort data, the unknown rates of discards (albeit discards are believed to be negligible), and IUU catch. Landings at age were not available for Russia and were derived using Ukrainian estimated age composition information.

Lack of annual research surveys at sea, covering the whole distribution area of the turbot population in the Black Sea, greatly limits the input of fishery independent data. Harmonization in age reading procedures between different laboratories in the region is necessary in order to avoid errors in data interpretation. Results from genetic studies, historical information on stock spatial distribution, tagging, behavioural ecology, spatial distribution of the catches, etc would be necessarytodefinethe population structure of the turbot stock in the Black Sea.

Progress since last Year in Addressing Gaps

No progress was made in addressing the data gaps identified last year.

5.3 Summary sheet for Whiting (*Merlangius merlangus*) in GSA 29

Species common name:	Whiting
Species scientific name	*Merlangius merlangus*
Geographical Sub-area(s) GSA(s):	GSA 29

Description of the Fisheries

In the waters of Bulgaria, Georgia, Romania, the Russian Federation and Ukraine there is rarely targeted fishing for whiting. Instead, whiting are caught as by-catch during trawl fishing targeted at other fish species or by non-selective fishing operations with fixed nets in the coastal sea areas. Turkey is the only country in the Black Sea region where there is targeted trawl fishing for whiting. The distribution of landings and the mean length of whiting is as follows: the target fishery – 95.7% (including bottom trawls – 82.1% and 16.1 cm, gillnets – 13.6% and 18.2 cm); by-catch – 4.3% (purse seine – 3.7% and 16.0 cm, lines - 0.6% and 19.6 cm).

Available Fishery-Dependent Data

The basis for the Whiting assessment is the data set prepared at EWG 12-16 with new data added for 2012.

National annual data on landings (tons). There is a full data set for the period 1980 to 2011. For 2012 data are available with the exception of Georgia and the Russian Federation. Landings from the Black Sea during 2012 were 6 332 t, down from the 2011 landings of 8 222 t.

Discards (tons). Data on the discards of whiting are available as follows: from Bulgaria for the period from 1980 to 1993;from Ukraine for the period 1992 to 2002; from Romania only for 2011 and 2012. Discard data for Georgia, the Russian Federation and Turkey are completely absent. The reported discards of whiting during 2012 were 14 t.

Landings at age (numbers of fish) and mean weight at age in the landings (kg / fish). Data on catch-at-age and weight-at-age are available for the period 1994 to 2011, but the information is sparse and has many gaps. The Romanian data are available only since 2002; the Turkish data are available for five years (2000, 2002, 2010 and 2011), Georgian and Russian data are completely absent. Missing data were reconstructed for these countries and are based on expert opinion. For 2012, data are available with the exception of Georgia and the Russian Federation.

Discards at age (numbers of fish). Data are available only for Romania (2011 and 2012) and Ukraine (1994-2002). In Turkish waters (Samsun shelf area) information was available on the rate of whiting discards observed in 2005-2011 but with no details of the age composition.

Mean weight at age in the discards. Data are available only for Romania (2011 and 2012).

Maturity ogives at age and natural mortality at age by area. Maturity ogives at age for 1994-2011 are based on averages for fish from Romania and Ukraine. For 2012 a whiting maturity ogive was available only for fish from Turkey. Estimates of whiting natural mortality by age are available only for the period of 1980-1990s.

The data set of landings was compiled for the period 1970 – 2012. The following table lists the landings (tons) by nation for 1980 - 2012.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Union Soviet Soc. Rep.
1980	30	-	618	-	6838	1102	2690
1981	1	-	894	-	4669	2083	2238
1982	4	-	800	-	4264	825	1513
1983	0	-	1080	-	11696	817	2381
1984	0	-	1192	-	11595	2252	4738
1985	0	-	3138	-	16036	1101	2655

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Union Soviet Soc. Rep.
1986	0	-	1949	-	17738	1867	2652
1987	0	-	615	-	27103	579	2764
1988	0	5	1009	736	28263	1482	2223
1989	0	5	2739	7	19283	584	-
1990	0	0	2653	235	16259	87	-
1991	0	0	59	210	18956	24	-
1992	0	70	1357	37	17923	0	-
1993	0	172	599	16	17844	4	-
1994	0	187	432	125	15084	64	-
1995	0	146	327	91	17562	17	-
1996	0	223	389	11	20326	3	-
1997	0	58	441	10	12725	29	-
1998	0	53	640	119	11863	55	-
1999	0	41	272.4	184	12459	18	-
2000	9	36.5	275.0	341	15343	20	-
2001	8	32	306.0	642	7781	18	-
2002	16	37*	85.0	656	7775	9	-
2003	13	45	113.4	93	7062	21	-
2004	2	29	117.6	55	7243	43	-
2005	3	30	93.3	78	6637	30	-
2006	2	37	96.7	60	7797	15	-
2007	16.1	41	17.1	22	11232	64	-
2008	0.4	15	55.2	96	10986	9	-
2009	2.3	15*	39.5	52	8979	17	-
2010	14.7	15*	23.6	23	11894	17	-
2011	1.0	42	0.1	20.9	8122	36	-
2012	1.4	42*	0.4	2.8	6251.4	34	-

* based on expert opinion

About 99% of landings of whiting since the 1990s were by vessels from Turkey, although its portion of the continental shelf in the Black Sea does not exceed 10%.

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.3).

Available Fishery-Independent Data

Survey tuning indexes of whiting abundance are reported for the Romanian research trawl surveys in 2008-2012. Tuning indices based on Turkish surveys of commercial vessels are available for 2009-2012. The compiled fishery-independent data are presented in the detailed assessment section (6.3).

Geographical distribution patterns of whiting in Romanian waters in 2012 for spring and autumn are given in the detailed assessmemt. Also provided for 2012 are two maps of the distribution of the whiting agglomerations (and corresponding biomass indices) along the Eastern Black Sea coasts of Turkey (the Samsun Shelf Area) and the Western Black Sea.

Fishing Effort

No information on fishing effort was provided to the EWG 13-12.

Stock Assessment Summary

The stock assessment was conducted using the XSA method applied to catch-at-age information from 1994 to 2012 for age-classes 2 to 6+. During this period the annual catch weight (age-2 to age-6+) varied around an average of about 7000 t during the first 10 years but then declined to the lowest point of the series (2159 t) in 2005. Annual catches rose steadily for the next five years to a peak value of almost 17 000 t in 2010 and then declined. Catch during 2012 was slightly less than 6000 t.

- State of the adult abundance and biomass (SSB):

From 1994 to 2012 for age-classes 2 to 6+ the SSB varied cyclically with peaks in 2000 and 2009, but the SSB estimate for 2012 is the lowest of the series (12677 t).Given the absence of a biomass reference point, the EWG 13-12 is unable to fully evaluate the stock status with respect to it.

- State of the juveniles (recruits):

EWG 13-12 is unable to fully evaluate the state of recruitment due to the selection of only age 2-6+ for the assessment. The available information on age-0 and age-1 fish was considered unreliable because there have been significant (but unquantifiable) amounts of discards of young whiting.

- State of exploitation:

The EWG 12-16 proposed F_{MSY} (1-4) ≤ 0.4 as the limit reference point consistent with high long term yields and low risk of fisheries collapse. As the estimated F(2-4) = 0.958exceeds this Fmsy, the EWG 13-12 classifies the stock of whiting in the Black Sea as being potentially exploited unsustainably. However, given the uncertainty regarding the amount of discards, the assessment results are mainly indicative of trends.

- Source of data and methods:

International landings at age were constructed for 1994-2012, but data on discards by age are incomplete for 1994-2002 and 2011-2012, and completely lacking for 2003-2010. The XSA analyses were tuned to data from a Romanian bottom trawl survey in 2008-2009 and by a second survey from Turkey for the period 2009-2012. Catch weight at age matrices were averaged across countries to derive a single mean weight at age matrix. Data from age-classes 0 and 1 were excluded from the XSA to reduce the influence of poor or missing estimates of discards of age-0 and age-1 whiting. The assessment was run using ages 2 to 6+ for the both the catch matrix and the tuning indexes.

The complete stock assessment results are presented in the Detailed Assessment (6.3).

Existing management measures

Information regarding management measures for 2012 is available for all the Black Sea nations with the exception of Georgia and the Russian Federation. For the rest of the riparian countries of the Black Sea region the fishery management measures for whiting include minimum landing sizes, closed areas, closed seasons and other technical measures.

In the waters of Turkey, from which the major portion of Black Sea whiting are taken, there are no annual quotas or restrictions on fishing effort, and the permitted mesh size in trawls and gillnets does not meet the scientific recommendations. It is likely that inadequate Turkish fishery management measures have contributed to the overfishing of whiting that has apparently occurred in recent years.

A complete description of management measures is presented in the Detailed Assessment (6.3).

Short and medium term scenarios:

A deterministic short term projection of stock size and catch was not performed due to the large uncertainty in the assessment results, caused by the poor quality of the discard data. The EWG 13-12 did not undertake medium and long term projections.

In the absence of an allocation key for the international catches of whiting, the EWG 13-12 is unable to suggest a specific EU TAC for whiting in the Black Sea. The vast majority of the catches of whiting are taken by vessels from Turkey.

The complete stock assessment projections are presented in the Detailed Assessment (6.3).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-12.

Fmsy(1-3) proxy derived from F0.1	≤ 0.40

Table of limit and precautionary management reference points agreed by fisheries managers.

Fmsy (age range) =	none
Bpa (Blim, spawning stock) =	none

Comments on the assessment

Data and Information Gaps

The EWG 13-12 identified the following knowledge and monitoring gaps regarding the whiting stock assessment:

- incomplete and breaks in the historical data series of landings, discards, landings-at-age, discard-at-age, landing weights-at-age, discard weights-at-age, natural mortality by age;
- discrepancies in determining the age of fish older than two years;
- lack of data collection on fishing effort that targets whiting;
- lack of national and international trawl/hydroacoustic surveys that cover an adequate portion of the area inhabited by whiting in the Black Sea.

EWG 13-12 suggest a series of monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps:

- to revise the existing national historic data on the length and age composition;
- to organize one or more workshops for the inter-calibration of age readings between different laboratories and scientists in the region;
- to explore the possibility (including financial support) of an international trawl/hydroacoustic survey that cover the whole area of distribution for the main demersal fishes in the Black Sea.

Progress since last Year in Addressing Gaps

No progress was made in improving the data quality and the assessment from last year.

5.4 Summary sheet of horse mackerel (*Trachurus mediterraneus ponticus* Aleev) in GSA 29

Species common name:	Horse mackerel
Species scientific name	*Trachurus mediterraneus ponticus* Aleev
Geographical Sub-area(s) GSA(s):	GSA 29

Description of the Fisheries

The catches of Black Sea horse mackerel were realized by active (bathypelagic trawls and surrounding nets) and passive fishing gears (gill netting, trawl net, trap nets). Most of the catch is taken by Turkish fishermen using active (bottom trawler, pelagic trawler and large bag-shaped nets) and passive (extension and longline) nets, with almost the entire horse mackerel catch (98.2%) being caught using large bag-shaped nets.

Available Fishery-Dependent Data

Landings data for Bulgaria, Romania, Turkey, Ukraine and Russia were provided from the official statistics of each country. Some of the horse mackerel biological data are lacking. The only available data for landings at age, mean weight at age in the landings, and maturity at age are for the period 2004-2012. Landings at age and weight at age were not available for the Russian Federation and Georgia, and were derived using Ukrainian estimated age and weight composition.

Landings data were compiled for the period 1950 – 2012, but are only shown for 1980 – 2012 in the table below. During the period 1956 – 1965 catches grew and reached a mean value of 19 008 tons. During the period 1966 – 1975 the total average catch increased to 21 042 tons. During the next decade (1976 – 1985) the horse mackerel catches again increased, from 20 576 to 141 078 tons. During the period 1986 – 1995 there was an abrupt decline in the catches from 97 741 to 15 906 tons. The next seven years (1996 – 2002) was a period of prolonged decline in the horse mackerel catch, reaching a mean value of 12 344 tons. In 1992 a catch of 21 065 t was achieved. From 1994 the amounts of catches decreased, especially during 1998-1999. In 2012 a considerable increase in the catches of horse mackerel was reported, to the level of 24 931 t.

Table of horse mackerel landings (tons) by nation.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Total
1980	813.0	-	1536	-	42339	-	45297.0
1981	476.2	-	588	-	40543	-	41951.2
1982	366.8	-	291	-	48918	-	51450.8
1983	496.7	-	1510	-	54548	-	63711.7
1984	1015.8	-	872	-	69980	-	77369.8
1985	755.8	-	1035	-	100417	-	141077.8
1986	850.9	-	945	-	100943	-	105108.9
1987	826.4	-	997	-	90850	-	93216.4
1988	1676.8	-	2660	-	93006	-	97740.8
1989	1100.9	-	1459	-	94023	-	96887.9
1990	164.1	-	165	-	65163	-	65548.1
1991	122.9	48	0	-	19781	-	19954.9
1992	54	0	22	0	20989	0	21065
1993	31	0	30	0	23945	0	24006
1994	80	0	35	1	25275	1	25392
1995	70	0	24	1	15809	2	15906
1996	68	0	10	0	16093	0	16171

1997	36	18	1	0	11097	5	11157
1998	40	13	15	2	8246	0	8316
1999	30	0	3	2	8331	1	8367.2
2000	111	35	8	2	16181	0	16336.8
2001	130	7	17	6	16750	1	16911
2002	141.5	19	21	28	8903	34	9146.5
2003	141.6	70	10	77	9213	745	10256.6
2004	73.9	56	14	105	9113	272	9633.9
2005	29.4	60	12	169	17003	329	17602.4
2006	62.834	55	19	200.5	12812	476	13625.3
2007	115.88	53	14	63.2	17429	211	17886.1
2008	179.607	8	11	154.2	20124	366	20842.9
2009	176.91	6*	17	124.	15905	260	16489.1
2010	165.27	5*	7	108.9	12929	190	13405.5
2011	394.84	44*	22.8	87.2	17746	264	18558.8
2012	381.37	44	20.0	69.5	23911.2	539.7	24931.4

* Based on expert opinion.

Available Fishery-Independent Data

No survey information on horse mackerel was provided to the EWG 13-12.

No data were available to prepare detailed maps of the distribution of horse mackerel and its fisheries.

Fishing Effort

No information on fishing effort was provided to the EWG 13-12.

Stock Assessment Summary

A stock assessment was attempted using XSA applied to catch-at-age data for age-classes 0 to 5+ for the period 2004 to 2012. During this period the annual catches increased markedly from just under 1 000 t to a peak of about 25 000 t in 2012. To provide a historical perspective, the reported landings of horse mackerel have been as high as 141 078 t (in 1985).

- State of the adult abundance and biomass (SSB):

The assessment is considered only indicative of relative stock trends. All assessment formulations indicate that the SSB in 2012 is increasing from the previous year. In the absence of total stock size estimates and biological reference points, the EWG 13-12 is unable to fully evaluate the stock size with regard to the precautionary approach.

- State of the juveniles (recruits):

Recruitment is indicated to have varied without a clear trend since 2004.

- State of exploitation:

Given the current state of the assessment of horse mackerel in the Black Sea, the EWG 13-12 is able neither to provide a biological reference point consistent with high long term yield nor to quantify the exploitation rate. Based on the assessment results the exploitation rate appears to have varied since 2004 without a clear trend. In the absence of biological reference points, the EWG 13-12 is unable to fully evaluate the exploitation state with regard to the precautionary approach.

- Source of data and methods:

The EWG 13-12 deemed the XSA results to be unreliable because the assessment produced unsatisfactory retrospective patterns and residual patterns, mainly because the tuning fleet, based on commercial CPUE data from Bulgaria, was considered unreliable and inappropriate for tuning the analysis because the bulk of the catches came from the Turkish series. The XSA analysis was therefore not retained by the EW13-12. An international hydro-acoustic survey is needed to monitor trends in the horse mackerel age-structure and stock biomass across all national waters of the Black Sea.

The complete stock assessment results are presented in the Detailed Assessment (6.4).

Existing management measures

The minimum landing size varies as follows: in Romania and Bulgaria it is 12 cm TL; in Ukraine it is 10 cm Standard length.

A complete description of management measures is presented in the Detailed Assessment (6.4).

Short and medium term scenarios:

Given the current state of the assessment of horse mackerel in the Black Sea, the EWG 13-12 is unable to provide catch projections or suggest advice for the medium term.

The complete stock assessment projections are presented in the Detailed Assessment (6.4).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-12.

Fmsy (age range)=	None
Bpa (Blim, spawning stock)=	None

Table of limit and precautionary management reference points agreed by fisheries managers.

Fmsy (age range) =	none
Bpa (Blim, spawning stock) =	none

Comments on the assessment

Data and Information Gaps

- The assessment lacks an appropriate tuning series.
- An international hydro-acoustic survey is needed to monitor trends in the horse mackerel age-structure and stock biomass across all national waters of the Black Sea.
- Lack of research surveys at sea, limits the input of fishery independent data.

Progress since last Year in Addressing Gaps

No progress was made in improving the data quality and the assessment from the previous year.

5.5 Summary sheet for Anchovy (*Engraulis encrasicolus*) in GSA 29

Species common name:	Anchovy
Species scientific name	*Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s):	GSA 29

Description of the Fisheries

Turkey still holds the largest fleet targeting Black Sea anchovy and the fleet fishes not only in the Turkish EEZ. In accordance with a bilateral agreement, since 2003, 18-20 purse seiners from the Turkish fleet move to Georgian waters as soon as the Black Sea anchovy season is over on the Turkish coast. The anchovy fleet is characterized by purse seiners usually coupled with a carrier boat.In some years when the sprat fishery is not profitable, paired pelagic trawlers also take part in anchovy fishery. Other gears, such as gillnet, coastal trap or pound nets, make negligible contributions to the total landings.

Available Fishery-Dependent Data

Of the six Black Sea countries, five are involved in the Black Sea anchovy fishery and provided input to the assessment. The Russian Federation is the exception as they fish only Azov anchovy (*Engraulis encrasicolus maeoticus*) and only a negligible quantity of the Black Sea anchovy (*Engraulis encrasicolus ponticus*) exist in Russian waters. The landings of Bulgaria, Romania, Turkey and Ukraine, the age composition of the landings, and the mean weight at age in the landings were made available to the assessment. Turkey and Romania provided estimates of the quantity of discarded anchovies by age and the mean weight of the discards by age. The maturity ogives and natural mortality estimates were assumed to be unchanged since the last assessment.In general, the total anchovy catch dropped markedly in 2012; in contrast to the general decline, Georgia in 2012 filled its annual quota for the first time since a quota was first established in 2007.

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.5).

The following table lists the landings (tons) by nation.

Year	Bulgaria	Georgia	Romania	Turkey	Ukraine	USSR *
1980	209			239289		165900
1981	70			259767		153272
1982	266			266523		175100
1983	784			289860		200630
1984	239			318917		240640
1985	92			273274		110200
1986	96			274740		191370
1987	13			295902		66241
1988	115	97452		295000		
1989		32401		96806		
1990		4656		66409		
1991		5643		79225		
1992		6871		155417	2572	
1993		1656		218866	1598	
1994		857	197	278667	242	
1995	35	1301	190	373782	888	
1996	23	1232	140	273239	596	

1997	44	2288	45	213780	3623
1998	48	2346	146	195996	1039
1999	36	1264	155	310801	4872
2000	64	1487	204	260670	7719
2001	102	941	186	288616	5915
2002	237	927	296	336419	6739
2003	131	2665	160	266069	8868
2004	88	2562	135	306656	5687
2005	14	2600	154	119255	6200
2006	6	9222	23	212081	4907
2007	60	17447	87	357089	3363
2008	28	25938	15	225344	3761
2009	42		21	185606	4653
2010	65	39857	50	203026	5051
2011	18	25919	41	205243	6932
2012	7.4	60000	18	126331	6823

* Landings composed mostly of Azov anchovy *(Engraulis encrasicolus maeoticus*).

Available Fishery-Independent Data

During the last two years Turkey has been the only country conducting fisheries surveys at sea for anchovy. These surveys involve basic hydroacoustic and pelagic trawl sampling. In July 2013 the survey was accompanied by egg and larvae sampling in order to determine the size of the spawning stock biomass within the Turkish EEZ. A series of maps displaying the geographical distribution of the anchovy during winter were produced to evaluate year to year changes in the southern dispersal of overwintering anchovy. The maps indicated that in winter 2012, the age-0 anchovy were distributed abnormally offshore and only a part of the population formed overwintering schools on the coast.

The compiled fishery-independent data are presented in the Detailed Assessment (6.5).

Fishing Effort

Most of the countries did not make available any data concerning their fishing effort. However, there has been a marked decrease in the fishing effort by the Turkish fishing fleet in the last decade. This is the consequence of the effort regulation measures recently enforced by Turkey, namely (i) restricting anchovy fishing to night hours only (16:00 to 08:00) since 2007; (ii) setting a depth limit (0-24 m) for purse seining; and (iii) a vessel buy-back program launched in 2012.

The compiled fishing effort data are presented in the Detailed Assessment (6.5).

Stock Assessment Summary

Two stock assessment methods (XSA and sVPA) were applied to Black Sea anchovy catch-at-age data for age-classes 0 to 4+ from the period 1988 to 2012. Also, the ASPIC surplus production method was applied to catch and effort (number of purse seine vessels) for the same period. During these years the annual catches of anchovy varied from about 129 thousand t to 386 thousand, with no particular trend except for a 6-year period of steady increase during 1990 to 1995. The landings during 2012 were 186 thousand t and lower than in 2011. To provide a historical perspective, the reported annual landings of Black Sea anchovy have been as high as 392.6 thousand t (in 1988).

- <u>State of the adult abundance and biomass (SSB):</u>

The spawning stock biomass, which dropped significantly in 2005, seems to be still low. Due to uncertainties in the assessment (XSA and SVPA) it is not clear if the situation is getting any better.

- <u>State of the juveniles (recruits):</u>

Despite the assessment uncertainties, there was a noticeable increase in the recruitment during recent years. The increase was particularly striking in the 2012-13 samples.

- <u>State of exploitation:</u>

The upward trend in the exploitation level seems to have stopped in 2004. The estimates from optimistic configurations (XSA with high shrinkage, SVPA and ASPIC) indicated a slight decrease in the fisheries mortality, particularly in the last two years.

- <u>Source of data and methods:</u>

The national "Black Sea anchovy" landings of the countries except Russian Federation (fishing only Azov anchovy) were partitioned into ages using age-length keys and length-frequency data. Discarded catch, reported by Turkey and Romania, were added to the landings. XSA was tuned by a single commercial CPUE index for the major Turkish purse seiner. Assessments using SVPA and ASPIC were also considered.

The complete stock assessment results are presented in the Detailed Assessment (6.5).

<u>Existing management measures</u>

The only country applying a catch quota to anchovy is Georgia (60 000 tons). The minimum landing size varies from country to country; with the largest in Bulgaria, Romania, and Turkey (9 cm total length) and the lowest in Georgia (7 cm, TL). In Turkey the anchovy fishery is restricted to night hours (16:00-08:00) and to winter months (15 Sep-Mar). As of 2011, purse seining is banned in the coastal zone in the bathymetric range of 0 to 24 m.

A complete description of management measures is presented in the Detailed Assessment (6.5).

<u>Short and medium term scenarios:</u>

The assessment results were not sufficient to produce catch projections for short or medium term scenarios. The drop in the SSB, particularly in the oldest age class, as opposed to an increase in recruitment, may indicate that an external factor is influencing the stock.

Limit and precautionary management reference points

None of the assessment approaches were able to produce results with appreciable certainty; therefore an assessment was not accepted. The age-structured XSA and SVPA methods did not work well with the anchovy data set that was available and produced very some large residuals and poor retrospective patterns. The APSIC results were in conflict with the age-structured models.

Table of limit and precautionary management reference points proposed by STECF EWG 13-12.

Fmsy (1-3) =	None
Bpa (Blim, spawning stock)=	None

Table of limit and precautionary management reference points agreed by fisheries managers.

Fmsy (age range)=	None
Bpa (Blim, spawning stock)=	None

Comments on the assessment

Data and Information Gaps

As there is increased control on the minimum fish size at the ports, the quantity of undersized small fishes (recruits) discarded at sea increases. The discard rate should be elaborated in a more explicit manner in future assessments. The assessment results are very sensitive to the age-length keys (ALKs) used to estimate the catch at age matrix and there are noticeable differences in the ALKs used by the countries. Whether or not these differences are linked to the biology of the fish needs to be explored and justified. Currently the acoustic survey data are limited to the past two or three years and results from the surveys could not be used in the assessments. Such data seem crucially important for the reliability of the assessment results. Historical effort data are another important gap. These data should be recovered and harmonized.

Progress since last Year in Addressing Gaps

For Turkish landings, longer series of length-frequency, catch at age and effort data were made available (24 years). The catch at age data were calculated based on the length-frequency time series, rather than individual reports of age-composition sampled using uncertain methodologies. Although results from the acoustic survey were not explicitly used in the assessment, the results were utilized in the Detailed Assessment. Also, the issue of discards of anchovy was elaborated, to a certain extent, by Romania and Turkey for the first time.

5.6 Summary sheet for piked dogfish (*Squalus acanthias*) in GSA 29

Species common name:	Piked Dogfish
Species scientific name	*Squalus acanthias*
Geographical Sub-area(s) GSA(s):	GSA 29

Piked dogfish inhabits the whole Black Sea shelf at water temperatures of 6 – 15º C. It undertakes extensive migrations. In autumn piked dogfish aggregate in large schools, accompanying anchovy and horse mackerel, and migrate to wintering grounds along the eastern and western coasts. Abundant wintering concentrations of piked dogfish are also observed in the North-western Black Sea, in waters of Ukraine and Romania at depths from 70-80 m down to 100-120 m, where they are located on the grounds with concentrations of whiting and sprat. As a predatory species, dogfish agglomerate especially in places where it finds prey species and environmental conditions are favorable for feeding and breeding.

Description of the Fisheries

In the Black Sea the largest catches of piked dogfish have been from along the coast of Turkey, although this species was not the target of any fisheries, instead being caught as by-catch in trawl and purse seine operations, mainly during the winter. In the rest of the Black Sea countries most piked dogfish are harvested during spring and autumn months by target fishing that uses gill-nets of 100 mm mesh-size or that uses long-lines, and as by-catch in trawl fisheries for sprat.

During the 24 years for which landings data are available the largest annual catches of piked dogfish occurred during the early years of the series, with the peak landings of 6 159 t in the first year of the series (1989). Although the cumulative landings were taken primarily by Turkey and Ukraine, piked dogfish has lost its commercial importance in these countries. In 2012 40% of the landings were produced by Bulgaria.

Available Fishery-Dependent Data

Data regarding landings at age, mean weight at age in the landings, maturity at age and natural mortality at age, including information for 2012, were provided to the EWG 13-12 only by Romania and Ukraine. The remaining riparian countries (Bulgaria, Georgia, Russia and Turkey) provided data only on landings. Also, data on growth parameters were provided only by Romania and Ukraine, and estimates of the size compositions of the catches were provided only by Romania. Analysis of the length and weight classes of the piked dogfish caught during the period 2010-2012 showed the presence of medium-size individuals, with lengths ranging from 89 to 134 cm, but predominantly from 107 to 122 cm.

Table of landings (t) by nation of piked dogfish from the Black Sea.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	TOTAL
1989	28	217	30	135	4558	1191	6159
1990	16	128	45	183	1059	1330	2761
1991	21	18	26	67	2017	775	2924
1992	15	14	52	15	2220	595	2911
1993	12	131	6	5	1055	409	1618
1994	12	45	2	11	2432	148	2650
1995	80	31	7	90	1562	67	1837
1996	64	71	5	19	1748	44	1951
1997	40	1	5	9	1510	20	1585

1998	28	550	5	6	855	38	1482
1999	25	18	5	9	1478	94	1629
2000	102	21	5	12	2390	71	2601
2001	126	27	5	27	576	134	895
2002	100	65	5	19	316	97	602
2003	51.3	40	5	29	184	172	481.3
2004	47.2	31	5	34	211	93	421.2
2005	14.5	35	5	19	102	75	250.5
2006	6.2	10	9	17	193	67	302.2
2007	24.0	2	17	32	91	45	211.0
2008	22.8	0.4	10	59	35	79	206.2
2009	9.5	1.5	4	14	159	47	235.0
2010	42	1.5	3	8.5	16	27	98.0
2011	38.1	1.5	4	3.6	26.5	30.5	104.2
2012	28.7	1.5	2.1	4.0	25.0	9.0	70.3

Available Fishery-Independent Data

From Black Sea riparian countries, only Romania reported data on demersal trawl surveys in the period 2009-2012. In Romanian waters the swept area method was applied to estimate the biomass of piked dogfish. Results for estimated piked dogfish biomasses in May and November of 2009- 2012 in Romanian waters are given in the following table and in Tables 6.6.3.1.2.2 - 6.6.3.1.2.9.

Species	2012	2011	2010	2009
Piked Dogfish	1436-1159	1.173-1.619	5.635-13.051	967-2.541

The calculated biomasses in the Romanian littoral zone ranged between 967 t and 5635 t. The Detailed Assessment (6.6) presents eight maps showing the seasonal distribution of piked dogfish agglomerations, and the abundance and biomass indices for the period 2008-2012.

The compiled fishery-independent data are presented in the Detailed Assessment (6.6).

Fishing Effort

The EWG 13-12 was not provided with quantitative information on fishing effort by all riparian countries. In 2011 and 2012 only Romania provided data regarding the number of gillnets by vessel length class. The number of vessels fishing gillnets for dogfish dropped from 265 in 2011 to 160 in 2012.

The compiled fishing effort data are presented in the Detailed Assessment (6.6).

Stock Assessment Summary

The EWG 13-12 used the VIT program for estimating abundance and fishing mortality of piked dogfish, and the program YPR-LEN (NOAA Fisheries Toolbox Version 3.1) for obtaining the reference points for dogfish in the Black Sea. Because results from these analyses depend very heavily on assumptions of unknown validity, they should be viewed as being uncertain but indicative of the possible status of piked dogfish. However, the EWG notes that piked dogfish are long-lived, late maturing, and have low fecundity, which means that the stock probably has very limited capability to rebound quickly once it becomes depleted. Further, the landings of piked dogfish have dropped steadily and dramatically since the start of the reported landings series, from more than 6 000 t in 1989 to only 70 t in 2012.

- State of the adult abundance and biomass (SSB):

Based on an assumed terminal F of 0.15, the SSB for piked dogfish in 2012 was estimated to be 44 523 t, which was the lowest value estimated for the time series.

- State of the juveniles (recruits):

The recruitment in 2012 was estimated to be 6 522 t.

- State of exploitation:

The fishing mortality rate during 2012 was estimated to be 0.239.

- Source of data and methods:

The catch-at-age matrices were based on length compositions and age/length keys from Ukrainian and Romanian samples. The VIT software was applied to assess the population variables based on pseudo-cohort analyses for data from 1989-2012. The final results were based on the analysis that assumed M = 0.15 and that terminal F = 0.15.

The complete stock assessment results are presented in the Detailed Assessment (6.6).

Existing management measures

In the Black Sea area there are few management measures to protect the piked dogfish stock. For protecting the reproduction and rehabilitation of the piked dogfish stock, Romania adopted the following measures in its marine area:

- fishing for piked dogfish is prohibited for 60 days during April - June;
- use of trawl gear is banned in the marine zone depths less than 20 m;
- the mesh size for dogfish gillnets is 200 mm (stretched);
- the minimum admissible length in retained catches is 120 cm (TL)

In Ukraine, the mesh size for dogfish gillnets is 200 mm (stretched).

A complete description of management measures is presented in the Detailed Assessment (6.6).

Short and medium term scenarios:

Given the data that were available the EWG 13-12 was unable to make projections for 2013, 2014, 2015 of spawning stock biomass, recruitment or catches. The EWG cannot estimate a TAC constraint for 2013. However, the EWG notes that the results of the VIT analyses indicate that the biomass of piked dogfish has declined dramatically over the 24 years for which data are available, including during the most recent years.

The complete stock assessment projections are presented in the Detailed Assessment (6.6).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-12.

F 0.1 = (Fmsy proxy)	0.177

Table of limit and precautionary management reference points agreed by fisheries managers

Fmsy (age range)=	None
Bpa (Blim, spawning stock)=	None

Taking into account that the current F is estimated to be 0.238 the stock is considered to be overexploited.

Given the current state of the stock, the EWG 13-12 considers that fishing effort on dogfish should be reduced and that the Black Sea coastal states should undertake concerted actions to combat illegal fishing and to establish regional consultation mechanisms.

Comments on the assessment

Data and Information Gaps

The following text, which is from the 2012 report (EWG 12-15), remains fully relevant.

> *The lack of a fishery independent scientific survey to monitor dogfish all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. EWG 12 16 recommends such a survey to be established. Also age reading of dogfish needs to be calibrated between different national laboratories to avoid discrepancy between national catch-at-age data.*

Progress since last Year in Addressing Gaps

No progress has been made since last year.

5.7 Summary sheet for Red mullet (*Mullus barbatus*) in GSA 29

Species common name:	Red mullet
Species scientific name	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 29

Description of the Fisheries

Red mullet is one of the most important fish species fished and is consumed traditionally in the Black Sea countries. In Turkey, it is mostly caught by bottom trawls as a target fish species. Red mullet is the second most frequently caught demersal species after whiting, composing 9.5% of total demersal catches between 1991 and 1996 (Genç, 2000). Fishing with gillnets is also allowed in the red mullet fishery all along the Turkish coast and through all seasons, but only 10% of total landing is obtained by this method.

Catches of red mullet in EU waters are taken primarily by Bulgaria (131.5 t during 2012, 19% of the Black Sea total), with only small amounts landed by Romanian fishers (1.4 t during 2012, about 0.2% of the Black Sea total).

In the waters of Georgia, according to the official statistics, there were no catches of red mullet during 1989 – 1996, or the catches were reported within the "other fish" group. During 1997 – 2005 the mean annual catch was 28 tons. According to Komakhidze et al. (2003), the red mullet was captured recently in higher amounts that provided indirect evidence of increasing abundance.

Along the coasts of the Russian Federation target fisheries for red mullet are performed mainly with passive fishing gears. The stocks exceeded 100 tons by 1998, which was mainly related to the reduction of the population of comb jelly (*Mnemiopsis leidyi*) (Volovik and Agapov, 2003). In 2002, the total biomass of red mullet was estimated to be 1200 tons, with an exploited biomass of 960 tons and TAC of 200 tons.

In Ukrainian waters, target fishing for red mullet was permitted only with beach seines and bottom set traps. However, the greater part of the catches corresponded to the non-target fishing with bottom traps (Shlyakhov and Charova, 2003). The major share of red mullet was harvested during autumn in Balaklava Bay, near Sebastopol. The amount of unreported catches of red mullet cannot be evaluated at present.

Available Fishery-Dependent Data

Landings of Bulgaria and Romania are reported through the EU Data collection program. Landings data for Turkey and Russia were provided from the official national statistics. The catch at age matrix for the assessment was constructed based on landings data from all Black Sea countries except Ukraine as Ukraine is considered to exploit a different stock than other Black Sea countries. Age composition and weights of Turkish catches, (which account for 90% of the total catch on average) were used in the assessment.

Table of red mullet landings (tons) in the Black Sea.

Years	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
1988				129		
1989				324		
1990				132		
1991				210		
1992				37		
1993				2		
1994				25		
1995				324		
1996				76	2249	

1997				68	1173	
1998				119	1423	
1999				92	1853	
2000	5.0			127	910	10.3
2001	26.0			119	1110	20.9
2002	33.0			47	867	40.7
2003	36.0			177	506	35.8
2004	17.0			99	668	23.0
2005	1.0			151	1093	17.5
2006	6.0			140	960	56.1
2007	12.5			87	781	54.4
2008	17.0			115	706	48.9
2009	48.2			291.7	799	65.2
2010	72.4			200.3	507	68.2
2011	176.2	22	1.9	290.9	326.1	58.2
2012	131.5		1.4	144.4	347.3	78.9

Available Fishery-Independent Data

Age structured data (2009-2012 ages 1-5) from the Turkish Bottom Trawl Survey were used as a tuning index.

Maps of the biomass distribution from the survey in 2012 are provided in the Detailed Assessment.

Fishing Effort

No information on fishing effort was presented at the EWG 13-12 meeting.

Stock Assessment Summary

A quantitative assessment of the red mullet stock in the Black Sea was conducted using XSA applied to a catch-at-age matrix for age-0 to age-6+ fish, over the period 1990 to 2012. During this period there was a general decline in the annual catches from about 2500 t to 700 t.

- State of the adult abundance and biomass (SSB):

The SSB follows a consistent downward trend with periodic increases due to good recruitment. During the 1990s the SSB was in the range of 5000 - 6000 t, whereas in the recent years it dropped to about 1500-2000 t. SSB in 2012 is estimated at 1289 t.

- State of the juveniles (recruits):

Recruitment increased up to 2008 and since then started a decreasing trend. However, recruitment estimates are rather imprecise due to the lack of survey data. For catch forecasts recruitment is set equal to the geometric mean of the estimated recruitment values for 2009-2012.

- State of exploitation:

Total catches have been gradually decreasing since 1996 and there has been consistently high fishing pressure, due mainly to the Turkish fishery. Fishing mortality has been assessed as being consistently high since 1990, in the range 0.8 to 1.0, and well above the $F_{MSY} = 0.46$ level.

Under the status quo F assumption, catches are expected to remain low (around 740 t) in 2013 - 2015. Under F_{MSY} fishing the catches are expected to drop to levels of 467-556 t.

- Source of data and methods:

International landings data at age were constructed and the Extended Survivor Analysis (XSA) was applied. The short term predictions that are provided were based on assumed recruitment equal to the geometric average of recent recruitment.

The complete stock assessment results are presented in the Detailed Assessment (6.7).

Existing management measures

In Turkey the red mullet fishery is regulated by area and season closures, mesh size limitations, and minimum legal size limit. In Ukraine the fisheries regulations set the minimum commercial fishing size for red mullet, the allowable by-catch of juveniles in non-target fisheries, and the minimum mesh size in beach seines and in scrapers. In Bulgaria bottom-trawling is prohibited in Bulgarian waters and there is a closed season for all coastal fisheries.

A complete description of management measures is presented in the Detailed Assessment (6.7).

Short and medium term scenarios:

A short term prediction of stock size and catches, assuming a sustainable status quo fishing scenario, is provided together with a range of management options. Considering the short life span of red mullet in the Black Sea and the high variation in estimated recruitment, the EWG 13-12 emphasises that the short term projections are based on new recruitment being equal to the geometric mean of recent recruitment and that the resulting catch advice is subject to high uncertainty. The poor knowledge about the recruitment dynamics prevented the formulation of medium term projections.

The complete stock assessment projections are presented in the Detailed Assessment (6.7).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 13-12

$F_{0.1}$(Fmsy proxy)	≤ 0.46

Table of limit and precautionary management reference points agreed by fisheries managers

Fmsy (age range)=	none
Bpa (Blim. spawning stock)=	none

Comments on the assessment

Data and Information Gaps

- The assessment assumes that red mullet in the Black Sea form a unit stock, but the scientific basis for this assumption has not been established. Genetic, morphometric and life-history studies on red mullet in the Black Sea are needed to identify possible stock boundaries.
- More robust fishery sampling for age and size composition by all Black Sea nations is needed to provide better estimates of annual catch-at-age.
- The current assessment only has a single tuning index (based on Turkish data) and trends in that index may not be representative of trends in other regions where the stock occurs and is fished.

Progress since last Year in Addressing Gaps

This year a completely new assessment for red mullet was performed, covering 1990-2012 and based on newly reported data. The XSA was applied to catch-at-age data and used Turkish survey data for tuning. The assessment produced short term predictions, and a reference F_{MSY} proxy.

5.8 Summary sheet for Atlantic bonito (*Sarda sarda*) in GSA 29

Species common name:	Atlantic bonito
Species scientific name	*Sarda sarda*
Geographical Sub-area(s) GSA(s):	GSA 29

Description of the Fisheries

Fishing activity for bonito takes place in the Black Sea generally between August and February, and landings reach their highest levels during September and October. The vast majority of the bonito catches (85%) are caught by Turkish purse seine vessels, which can sometimes chase bonito shoals as far as 32 km from shore. Bonito are also caught to a lesser extent (15%) by smaller Turkish vessels fishing with surface gill nets.

Available Fishery-Dependent Data

Data on landings of Atlantic bonito in the Black Sea are available only for Turkey. The other Black Sea nations have essentially no reported landings of this species. No discard data for bonito are available. Length and weight data for bonito landed in Turkey were collected during the period 2000-2012, except for the years 2002-2004. Samples of bonito were collected from the Eastern Black Sea (Samsun- Hopa). In the available length frequency data almost all the fish were relatively small (< 50 cm) and there were very few large mature individuals, which suggests that the adult portion of this population may not reside in the Black Sea or is unavailable to fishing operations in the Black Sea.

The following table lists the Atlantic bonito landings (tons) by nation.

Years	Turkey	Bulgaria	Romania	Russian Federation	Ukrania	Georgia
1982	20151	4	0	0	0	0
1983	23369	24	0	0	0	0
1984	2602	1	0	0	0	0
1985	11126	1	0	0	0	0
1986	8648	0	0	0	0	0
1987	13313	13	0	0	0	0
1988	13833	0	0	0	0	0
1989	3872	0	0	0	0	0
1990	11256	17	0	0	0	0
1991	16144	15	0	0	0	0
1992	6337	12	0	0	0	0
1993	9461	8	0	0	0	0
1994	6877	0	0	0	0	0
1995	6866	25	0	0	0	0
1996	6752	33	0	0	0	0
1997	6044	16	0	0	0	0
1998	20480	51	0	0	0	0
1999	15233	20	0	0	0	0
2000	9737	35	0	0	0	0
2001	8237	49	0	0	0	0
2002	5175	0	0	0	0	0
2003	4939	23	0	0	0	0
2004	4693	18	0	0	0	0
2005	63896	56	0	0	0	0
2006	26463	8	0	0	0	0

2007	4246	1	0	0	0	0
2008	4536	16	0	0	0	0
2009	4216	5	0	0	0	0
2010	6322	16	0	0	0	0
2011	6726	8	0	0	0	0
2012	29854	96	0	0	0	0

Available Fishery-Independent Data

There are no fishery independent surveys for bonito in the Black Sea.

No data are available to support the production of maps of the distribution of bonito.

Fishing Effort

Since 1998 the number of purse seine vessels has varied annually in Turkey. There are no estimates of fishing effort for bonito except for 2012.

The compiled fishing effort data are presented in the Detailed Assessment (6.8).

Stock Assessment Summary

The EWG was not able to develop a quantitative assessment for this stock. However, information on the length frequency of the Turkish landings of bonito was assembled and growth curves were developed. The accuracy of the age determinations that underlie the growth curve estimates remains highly uncertain, particularly for the older fish, because of the scarcity of large fish.

- Most recent state of the stock

Given the absence of any biological reference points for this stock or estimates of spawning stock biomass, the EWG 13-12 was unable to evaluate the stock status.

- State of the juveniles (recruits)

The EWG was not able to estimate recruitment of bonito. However, the vast majority of the sampled catch consisted of young of the year fish, which implies that the catch is driven almost entirely by new recruitment. The spawning biomass that is the parental source of recruitment remains unknown.

- State of exploitation

The EWG was unable to develop estimates of fishing mortality for bonito in the Black Sea.

- Source of data and methods:

Other than data on landings of bonito in Turkey, the only data on bonito in the Black Sea are length and weight measurements from fish sampled between 2000 and 2012 from market landings in Turkey, or purse seine and gill net catches from off the Turkish coast. The length frequency tabulations of these fish were analyzed to identify age modes and derive growth curves. Length-weight relationships were also derived.

Further summaries and interpretations of the available data are presented in the Detailed Assessment (6.8).

Existing management measures

Atlantic bonito fisheries in Turkey are regulated by the Commercial Fishery Advice of the General Directorate of Fishery. For purse seines, it is not allowed in shallower waters within 24 m of the coast. The depth of purse seine nets must not be more than 164 m. The fishing season using purse seines is between 1 September and 15 April.

Short and medium term scenarios:

The EWG was unable to develop any projections for this stock.

Limit and precautionary management reference points

There are no limit and precautionary management reference points proposed by STECF EWG 13-12.

Table of limit and precautionary management reference points proposed by STECF EWG 13-12.

Fmsy(age range)=	None

Table of limit and precautionary management reference points agreed by fisheries managers.

Fmsy (age range)=	None
Bpa (Blim, spawning stock)=	None

Comments on the assessment

Data and Information Gaps

- Turkey should be encouraged to continue sampling its landings of bonito at a fine temporal scale (e.g., monthly) to provide a base of information that will clarify the growth of bonito and the relative strength of recruiting cohorts.
- Ichthyoplankton samples from oceanographic surveys should be explored for evidence that bonito spawn in the Black Sea and to identify spawning seasons and locations.
- An international survey is needed to monitor the distribution and abundance of bonito across all waters of the Black Sea, including the national waters of Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine.

Progress since last Year in Addressing Gaps

The 2012 EWG report identified the importance of Atlantic bonito and suggested that the available information be explored, with the aim of evaluating the potential for assessing this stock in the future. Although significant data gaps remain, the information compiled during EWG 13-12 and presented in the Detailed Assessment (6.8) is a significant improvement in the base of knowledge and information to support fishery management decisions regarding Atlantic bonito in the Black Sea.

5.9 Summary sheet of Rapa whelk (*Rapana venosa*) in GSA 29

Species common name:	Rapa whelk
Species scientific name	*Rapana venosa*
Geographical Sub-area(s) GSA(s):	GSA 29

Description of the Fisheries

Mainly the dredging method is used for harvesting rapa whelk in the Black Sea. In Turkey dredges for rapana are 3 m long, metal framed and have an “H” shaped structure that sustains the catching efficiency if the dredge is over-turned by obstacles on the bottom. Another type of dredge is used in Ukraine, called “Khizhyak's dredge”. It is a metal dredge with sieves on the sides and upper part. A third method for harvesting rapana is to collect them by scuba diving, which is more selective and enables the collection of larger individuals that receive a higher market price. Scuba diving for rapana occurs in Bulgaria and Turkey for commercial purposes, and is used in Romania and Ukraine mainly for conducting surveys.

According to the national fishery statistics rapana production had an increasing trend in 2012. Turkey is the main producer, harvesting 8893 tons, followed by Bulgaria with 3793 tons, Romania with 589 tons and Ukraine with 513 tons; with 13 788 tons as the Black Sea total. No landings statistics were provided by Romania, Russian Federation or Georgia. Total production of rapana in 2012 increased 21% compared to 2011.

Due to high the apparently exploitation rate in Turkey, the rapana harvested from Turkish waters are generally smaller than the rapana harvested in Bulgaria, Romania and Ukraine, which have populations of rapana that are relatively under-exploited.

Available Fishery-Dependent Data

Rapana venosa is one of the data poor species in the Black Sea. Three countries (Bulgaria, Turkey, and Ukraine) provided landings data for 2012, but most other standard types of data were not available. Ukraine provided age-length keys and Turkey provided some detailed length frequency data. Due to difficulties determining the ages of these animals, length data grouped by 0.5mm intervals were used to investigate the growth of rapana. However, none of the countries have regular programs for collecting data from the fisheries for rapana. Data from Turkey generally come from MSc and PhD research studies and surveys carried out for other purposes. Historically, the last data from Ukraine are for 2008, and no data have been provided from Bulgaria (other than total catch), Romania, Russian Federation and Georgia. Even Turkey does not have a complete time series of data. There are large intervals between survey years.

According to the decision of the STECF, the first report on rapa whelk was prepared in the EWG meeting in Cadiz during 11-15 October 2010. Since then there has been little progress by the countries to collect national data on rapana. In the case of Bulgaria and Romania, their Data Collection program does not include rapana. Ukraine and Turkey are the only sources of data, but the information is very limited.

Table of landings (tons) of rapa whelk harvested from the Black Sea.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	BS Total
1983					235		235
1984					122		122
1985					78		78
1986					2030		2030
1987					643		643
1988					7195		7195
1989					9239		9239

1990			75	6094		6169
1991			70	3738		3808
1992			110	3519	14	3643
1993			45	3668	3	3716
1994	3000			2607	5	5612
1995	3120	700		1198	303	5321
1996	3260	711		2447	378	6796
1997	4900	118		2021	476	7515
1998	4300	-		3998	371	8669
1999	3800	-		3588	619	8007
2000	3800	184		2140	913	7037
2001	3353	517		2614	400	6884
2002	698	503		6241	93	7535
2003	325	295		5500	154	6274
2004	2428	65		14034	182	16709
2005	511	70		12156	171	12908
2006	2773	300		10910	200	14183
2007	4310	-		13106	250	17666
2008	2872	-		11268	138	14278
2009	2214	-		6085	191	8490
2010	4381	-		5460	230	10071
2011	3119	-	218	7770	189	11296
2012	3793	-	589	8893	513	13788

The complete sets of compiled fishery-dependent data are presented in the Detailed Assessment (6.9.1.4.).

No data were available to prepare detailed maps of the distribution of rapana and its fisheries, but it can be said in general that rapana are harvested during the fishing season along the coast line to depths of 15 m. No maps were provided by the experts due to the lack of data.

Fishing Effort

In Turkey there were 240 vessels licensed in 2012 for rapa whelk fishing, and the overall length of these vessels ranged from 10 to 15 m OAL. No information on fishing effort was provided by the other countries, but probably there are around 250 vessels fishing for rapana in all the Black Sea. For fishing along the Turkish coast the CPUE was calculated as 37.05 tons per vessel or about 10.1 tons per square kilometres. Fishing effort and CPUE in recent years show a slightly increasing trend.

The compiled fishing effort data are presented in the Detailed Assessment (Tables 6.9.1.4.2. and 6.9.1.4.4.).

Stock Assessment Summary

As rapa whelk is a species that was added after the initial formation of the EU data collection framework, rapana was not included in the data collection regulations, which requires Member States to provide relevant data. The EU data collection regulations only apply to Bulgaria and Romania. For the current STECF EWG 13-12 meeting experts from all Black Sea riparian countries were expected to provide data about rapana, and all the available historical data were collected. However, the quality and quantity of the data were evaluated and found to be insufficient to apply any of the currently available assessment methods. At the advice of the working group the existing length composition data were compiled and examined with respect to their suitability to provide estimates of growth and age composition.

Rapa whelk are an invasive species that has become well established in the Black Sea. Turkey has been the largest harvester of Black Sea rapana. Turkish landings reached their peak level of just over 14 thousand tons in 2004, and landings during 2012, at slightly less than 9 thousand tons, were greatly reduced from this peak level

(63% of the peak). The size compositions of the Turkish samples of rapana are markedly smaller than the size compositions of the Ukrainian samples, which probably reflect much higher rates of exploitation of rapana in Turkish waters.

- State of the adult abundance and biomass (SSB):

Because of the lack of data to conduct a quantitative stock assessment, the SSB could not be estimated. In the absence of a consistent method for identifying cohorts in length frequency distributions, the EWG 13-12 was unable to fully evaluate the stock's status with respect to SSB.

- State of the juveniles (recruits):

No surveys have been conducted to assess the recruitment of rapana in any of the Black Sea countries, nor have there been any stock assessment estimates of recruitment.

- State of exploitation:

The EWG 13-12 was not able to evaluate the current exploitation rate or to estimate a reference exploitation level that would result in sustainable harvesting of the stock.

- Source of data and methods:

International landings data were compiled and length composition summaries were constructed. Discards are considered to be negligible. Due to the lack of any clear indications of cohorts in the length compositions, no assessment was performed. According to data from Ukraine, age-length keys had been derived based on their ageing method. The Turkish size data were converted to size at age data using the Ukrainian age-length key, but the results were considered to be unreliable because the Ukrainian rapana, which ranged in shell length from about 40 to 105 mm, were much larger than the Turkish rapana, which ranged in shell length from about 20 to 95 mm. The age-composition estimates that resulted from applying the Ukrainian age-length key were not considered to be suitable for the application of any further assessment methods.

The complete stock studies are presented in the Detailed Assessment (6.9.1.3).

Existing management measures

In Bulgaria, fishing for rapana is permitted only by the scuba diving method and a license system is also in force. In Ukraine, an annual limit on sea snail harvesting (up to 400 t) was introduced in 2002. In Turkey, the Ministry of Food, Agriculture and Livestock implemented three forms of limitation to the fishery for rapa whelk. The first type of regulation restricts the fishing method to scuba diving in the western part of Turkish waters and to dredging (with minimum mesh size of 40 mm) in the eastern part. The second form of regulation is a fishing season, with scuba diving allowed throughout the year but dredges banned between 1 May and 30 August. In addition, fishing at night is also banned. The third form of regulation is area limitations, such as a closure to fishing for rapana in waters that are more than 500 m from the coast. In practice, these regulations were never enforced and illegal fishing operations increased in later years.

A complete description of management measures is presented in the Detailed Assessment (6.9.1.4.).

Short and medium term scenarios:

Due to the lack of a quantitative stock assessment, the EWG 13-12 was unable to provide any short or medium term projections for the stock size or catch of rapa whelk.

Due to its high importance as a predator on benthic fauna, monitoring of the rapana stock(s) is very important. Also, implementation of management measures for the rapana population needs to be coordinated on a regional basis.

Limit and precautionary management reference points

There are no limit and precautionary management reference points proposed by STECF EWG 13-12.

Fmsy (age range)= None

Table of limit and precautionary management reference points agreed by fisheries managers.

Fmsy (age range)=	None
Bpa (Blim, spawning stock)=	None

Comments on the assessment

Data and Information Gaps

- All countries should include rapa whelk in their data collection programs.
- The same type of dredge should be used in surveys of rapana to facilitate the standardization of CPUE for stock assessments and comparative studies.
- Age determination of rapa whelk is an important technical problem and region-wide harmonization of methods for ageing would be very beneficial for comparative studies of rapana.
- It remains unclear whether rapana in the Black Sea are a single stock or several independent stocks.
- Protocols for sampling and ageing should be prepared by experts from the Black Sea

Progress since last Year in Addressing Gaps

The 2012 EWG report did not include any noteworthy information on fisheries for rapa whelk in the Black Sea. Although significant gaps remain, the information compiled during EWG 13-12 and presented in the Detailed Assessment (6.9) is a significant improvement in the base of knowledge and information to support fishery management decisions regarding rapa whelk.

6 DETAILED ASSESSMENTS

6.1 Sprat in the Black Sea

6.1.1 *Biological features*

6.1.1.1 *Stock Identification*

The Black Sea sprat (*Sprattus sprattus L.*) is a key species in the Black Sea ecosystem. Sprat is a marine pelagic schooling species sometimes entering in the estuaries (especially as juveniles) and the Azov Sea and tolerating salinities as low as 4‰. In the daytime it keeps to deeper water and in the night moves near the surface. It forms big schools and undertakes seasonal movements between foraging (inshore) and spawning (open sea) areas (Ivanov and Beverton 1985). Adults tend to remain under the seasonal thermocline. penetrating above its only during the spring and autumn homothermia. Juveniles are distributed in a larger area near the surface. Sexual maturity is attained at the age of 1 year and length of 7 cm. In Turkey it was found that males reached maturity at 7.5 cm and females at 7.8 cm at age 1 year (Avşar & Bingel 1994).

Sprat is one of the most important fish species being fished and consumed traditionally in the Black Sea countries. It is most abundant small pelagic fish species in the region together with anchovy and horse mackerel and accounts for most of the landings in the north-western part of the Black Sea. Whiting is also taken as a by-catch in the sprat fishery although there is no targeted fishery beyond this (Raykov 2006) except forTurkishwaters.

Sprat fishing takes place on the continental shelf on 15-110 m of depth (Shlyakhov and Shlyakhova. 2011). The harvesting of the Black Sea sprat is conducted during the day time when its aggregations become denser and are successfully fished with trawls. The main fishing gears are mid-water otter trawl pelagic pair trawls and uncovered pound nets.

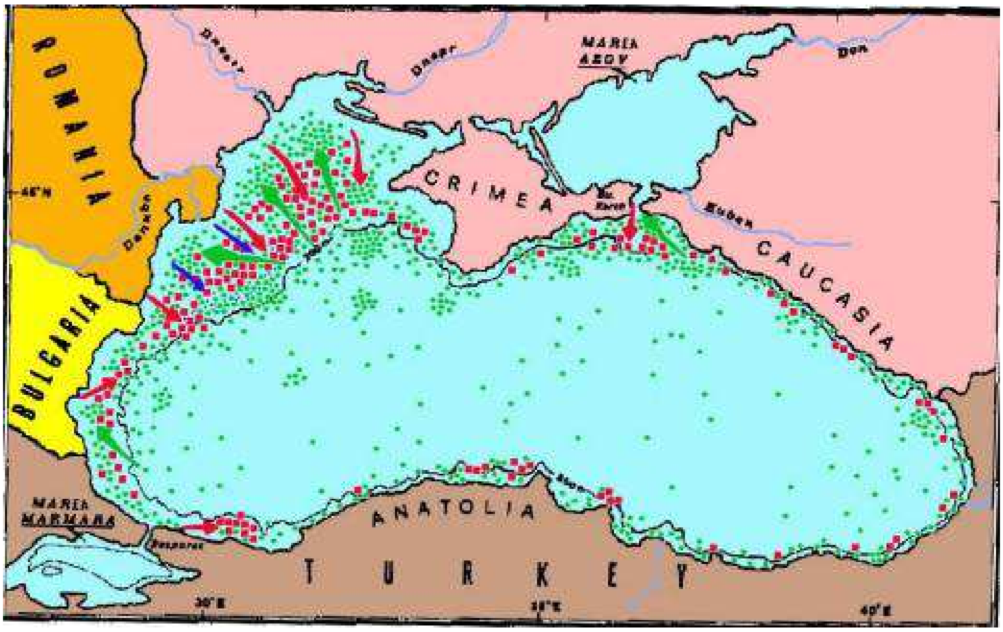


Fig. 6.1.1.1.1. Sprat distribution and migration in the Black Sea

Legend: Wintering areas and migration to | Spawning areas and migration to them | Feeding areas and migration to them

6.1.1.2 *Growth*

The species is fast growing; age comprises 4-5 age groups. The von Bertlanffy Growth Parameters VBGF by countries for 2012 is given in Table 6.1.1.2.1. In Romanian waters asymptotic length and growth rate is comparable with the growth parameters derived in Bulgarian and Ukrainian Black Sea waters (Table 6.1.1.2.1).

Table 6.1.1.2.1. VBGF parameters calculated in the Black Sea for 2012.

	L∞	**k**	**t_0**	**a**	**b**
Bulgaria	12.08	0.66	-1.33	0.008	2.78426
Romania	12.1	0.3497	-1.67	0.00642	2.974
Ukraine	12.42	0.286	-1.504	0.008475	2.9691
Turkey	13.039	0.445	-1.096	0.004	1.878849

Sprat has lengths comprised between 50 and 115 mm. The highest frequency pertaining to the individuals of 70-100 mm lengths. While the share of eldest age decreased the prevalence of 0+ especially 1-1+ ages became increased. During last years the age structure show the presence of the specimens of 1-1^+ and 3; 3^+ years. The catch base was the individuals of 1-1^+ and 2-2^+ years (Figure 6.1.1.2.1.).

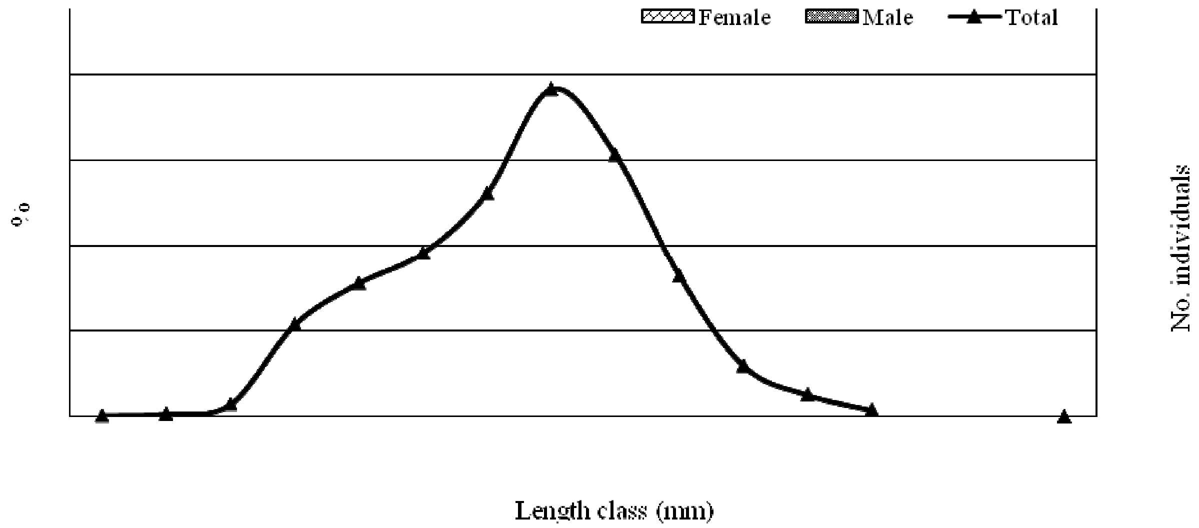


Fig. 6.1.1.2.1. Length distributions of sprat (%. No. of individuals) in the 2012 catch from the western Black Sea.

Although sprat catches were low in autumn survey 2012 (november-december), they were composed of mature specimens of 50 - 115 mm / 1.37 – 8.012 g, aged 1-3 years, the dominant classes are 65.5 - 100 mm / 1,98 - 6,01 g, 2 years (60.0%). Average body length was 89.79 mm and the average mass of 4.263 g. The sexes ratio indicates a clear dominance of females (60.43%) than males (39.57%). The composition by age of sprat catches reveals the existence of specimens between 1 to 3years. Most of the individuals are 2 years old (59.23%), followed closely by those of 1 years (35.18%) and of 3 years old (5.56%) Fig. 6.1.1.2.1. (Maximov, 2012).

The modal length classes from 2010 and 2011 (Figure 6.1.1.2.1.) are similar as the largest specimen over 11.5 cm was presented in the catch with low percent.

Bulgarian catch length- frequence analyses show clearly dominance of the 7.5 – 8.00 cm length classess,while the bigger fish were presented with lower percentage in the sam-fvghjples (Fig. 6.1.1.2.2.).

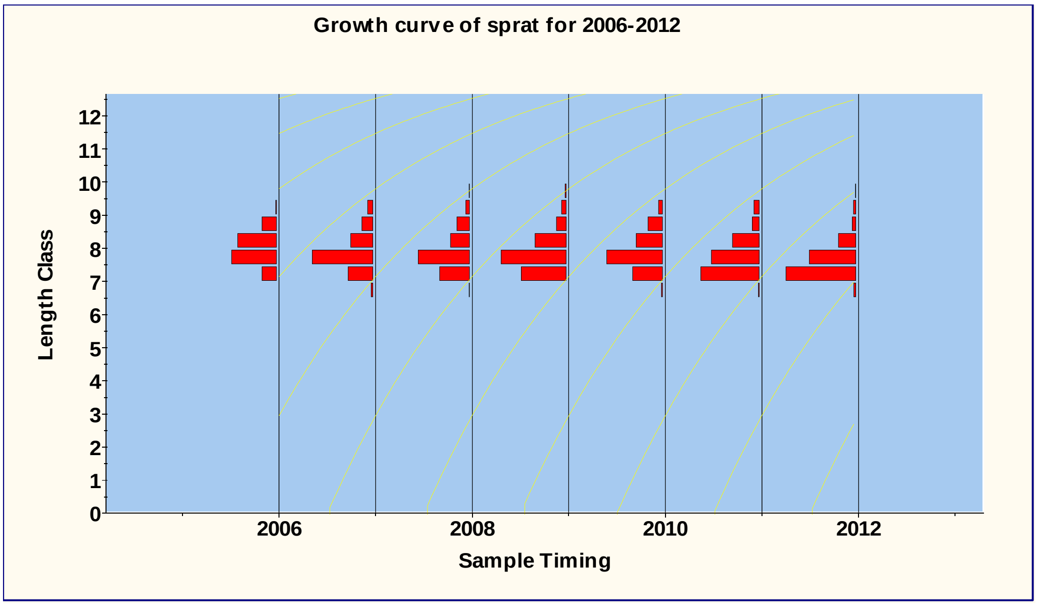
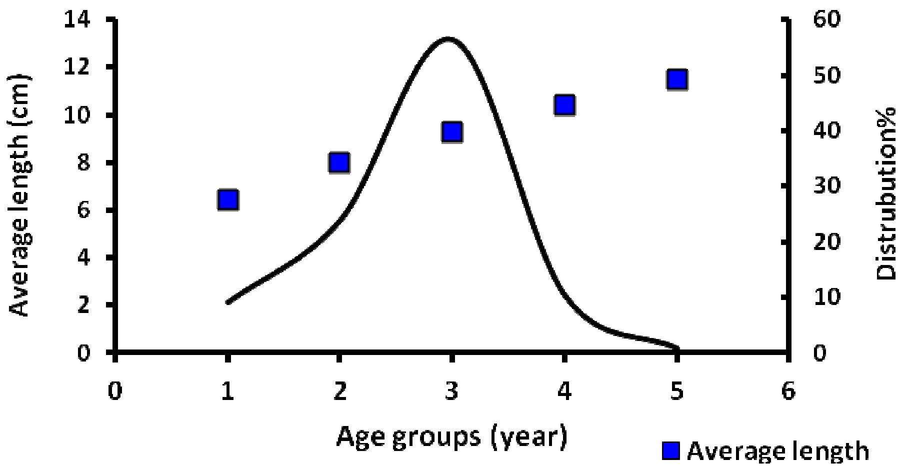


Fig. 6.1.1.2.2. Growth curve of sprat from Bulgarian Black Sea waters. 2006-2012.

The age groups and average length distribution (for Turkish waters in 2012) were presented in Figure 6.1.1.2.3. The age range was determined as 1-5 years.



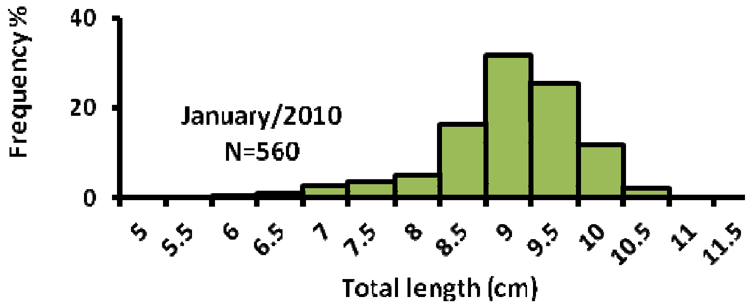
6.1.1.2.3. Age groups and average length distribution of *Sprattus sprattus* in the Samsun Shelf Area in 2010 (Zengin et al. 2011).

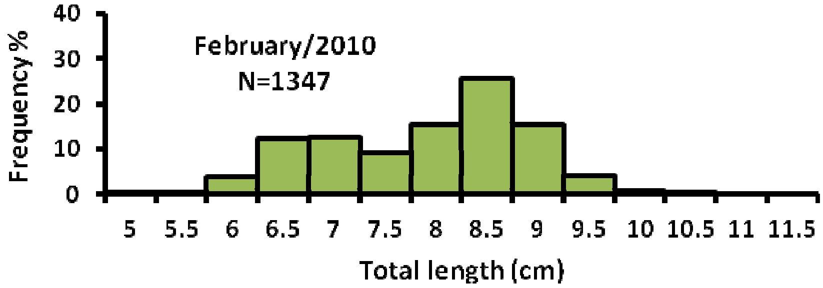
The length range was determined by different authors as 3.3-13.6 cm for the period between 1990 and 2010 along the Turkish coasts. Scientific studies even if at irregular basis displayed data about average length of sprat population. The average length for 1991 was 10.7 cm, 9.4 cm for 1995, 8.8 cm for 2000, 8.4 cm for 2005, 8.6 cm for 2008 and 8.9 cm for 2010. Considering the average length in the last two decades for the southern coasts of Black Sea, it can be roughly said that the sprat is not exposed to a significant fishing pressure. At least, the actual landing in 2010 confirms this statement. The sprat fishery started at the beginning of 2000s and increased rapidly in the last decade in The Turkish coasts. For this reason, perhaps being the unique population in Turkish coasts that has not been previously exploited–or slightly exploited-the sprat population may likely give response to heavy exploitation in future years. The parameters of fishery until 2010 do not reflect a fishing pressure on population but threatens a steadily increased fishing effort. Another important indicator can be mentioned as the growing demand on sprat by the regional fishing industry producing fish oil and meal.

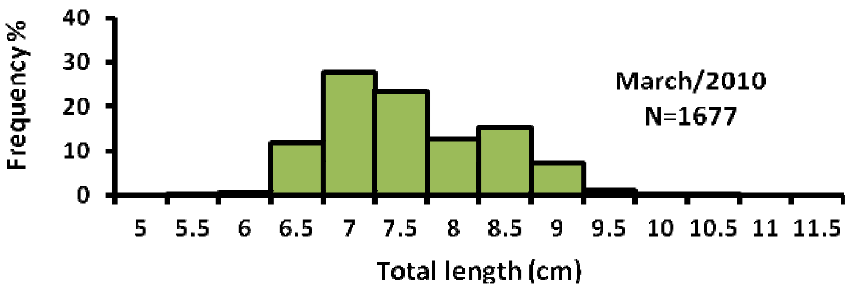
The mesh size in pelagic trawl nets used for sprat fishery is 12 mm in Samsun Shelf Area. The catch of this mesh size is largely (80%) composed of mature 2 and 3 age group individuals with average total lengths of 8.0 cm and 9.3 cm, respectively (6.1.1.2.3.).Considering the length-at-age data, the rate of 1 year old individuals in catch composition is only 9%. It can be concluded that the actual fishery already using 12 mm mesh size do not make any negative impact on immature population and can be defined as confident in Samsun Shelf Area. However, the fishery should be more deliberate in the period of new recruitments namely in March, April and May. Because the ratio of the young individuals was found to be relatively higher in the fall and winter than in the sampling of spring period with commercial vessels (6.1.1.2.4. and 6.1.1.2.5.).

The monthly length-frequency distributions of sprat sampled with commercial fishermen reveals the sensitive period of population very clearly. In the fishing season starting by September 15 and ended by May 15, the length-frequency distributions display quite different patterns in fall, winter and spring (6.1.1.2.4.). In fall (September, October and November) almost all of the population is composed of mature individuals. The length range for this period was from 8.0 cm to 9.5 cm. In February, while the spawning decreased gradiently, the rate of immature individuals was 30% and new recruits started to be observed. The rate of young individuals in the population rate is 40.3% in March, 62.3% in April and 55.5% in May. In spring which is the period of high recruitment, the length range of the population was 5.1-1.0 cm (Zengin et al., 2011). Those findings are derived from only one-year data and certainly require confirmation with successive studies.

The management of population in spring requires much more sensititivity than in fall or winter as the sprat school involving new recruits moves toward the near shore ecosystem. Here, the sprat shares habitat with other benthopelagic macro fauna. For this reason, by the end of bottom trawl fishing season at April 15, in the one-month period -until May 15- the sprat fishery should not be allowed in waters below 40 m depth. Out of this period, there is no prohibition for any depth in sprat fishery. This is a reasonable management strategy to conserve the young population. On the other hand, along the waters deeper than 40 m, the mesh size of 12 mm which is already in practice is sufficient to maintain the population which is largely composed of new recruits. Because, Zengin et al (2002) estimated the optimum length of selectivity (L_{50}) as 11.5 cm for the trawl net of 12 mm mesh size in a study carried out about pelagic trawl selectivity in Samsun Shelf Region. The selectivity length of 11.5 cm may seem a little high in terms of the yield obtained. But, considering the minimum selectivity length (L_{25}) at least 9-9.5 cm individuals are still catchable (Zengin et al., 2002).


Frequency %
40
20
0
January/2010
N=560
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
Total length (cm)


Frequency %
40
30
20
10
0
February/2010
N=1347
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
Total length (cm)


Frequency %
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30
20
10
0
March/2010
N=1677
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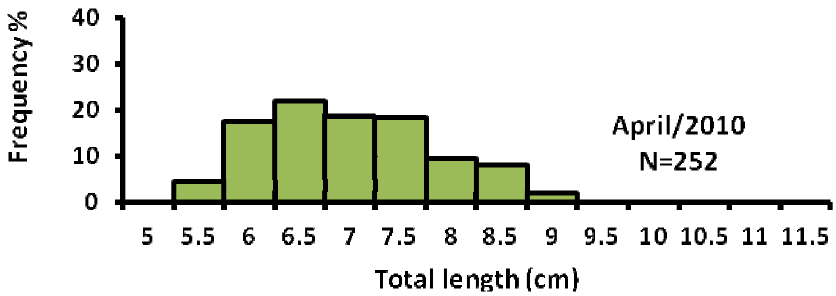
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
Total length (cm)


Frequency %
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30
20
10
0
April/2010
N=252
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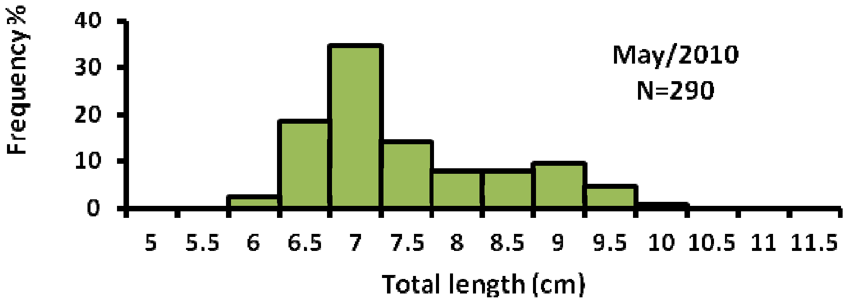
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
Total length (cm)


Frequency %
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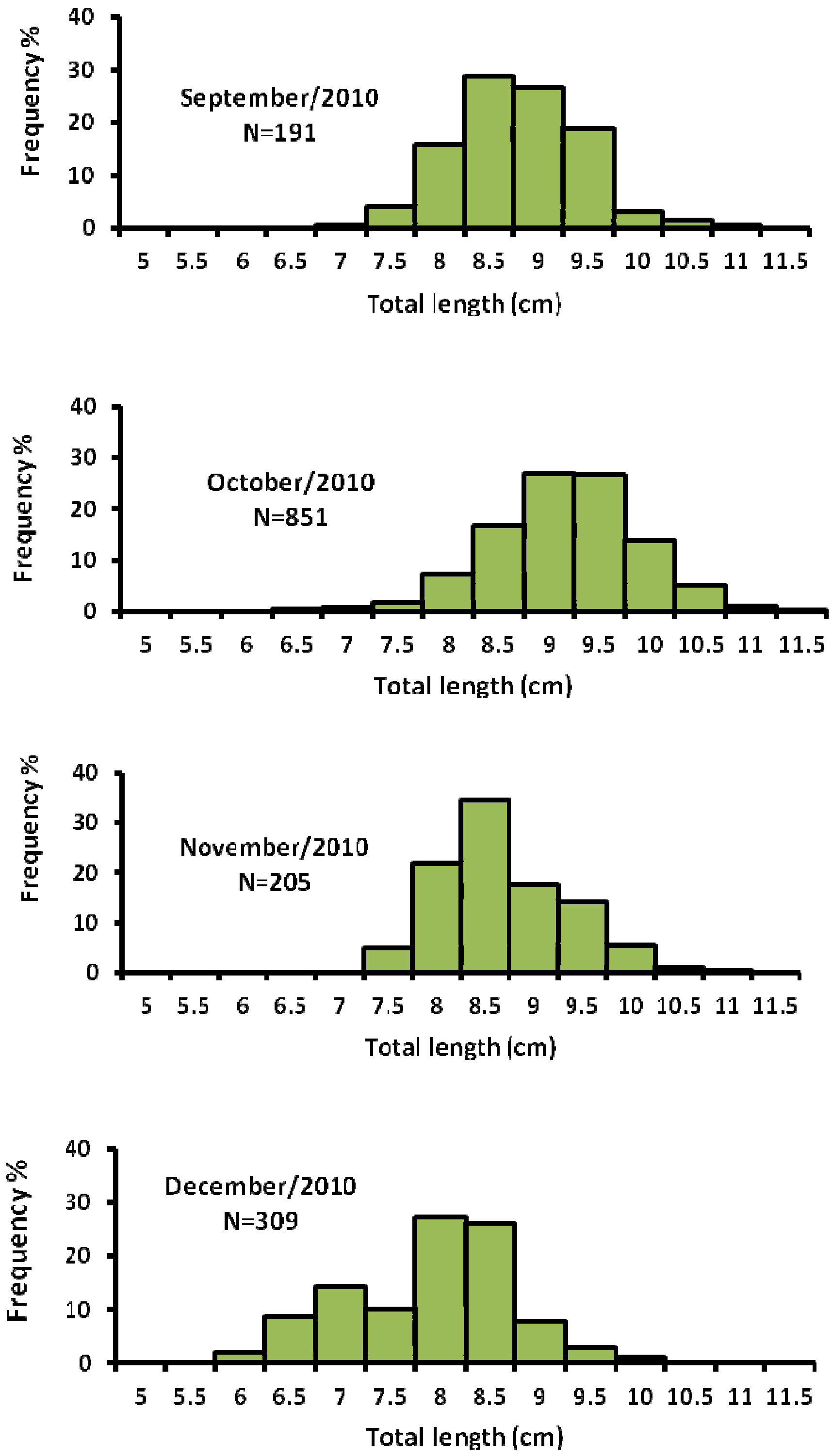
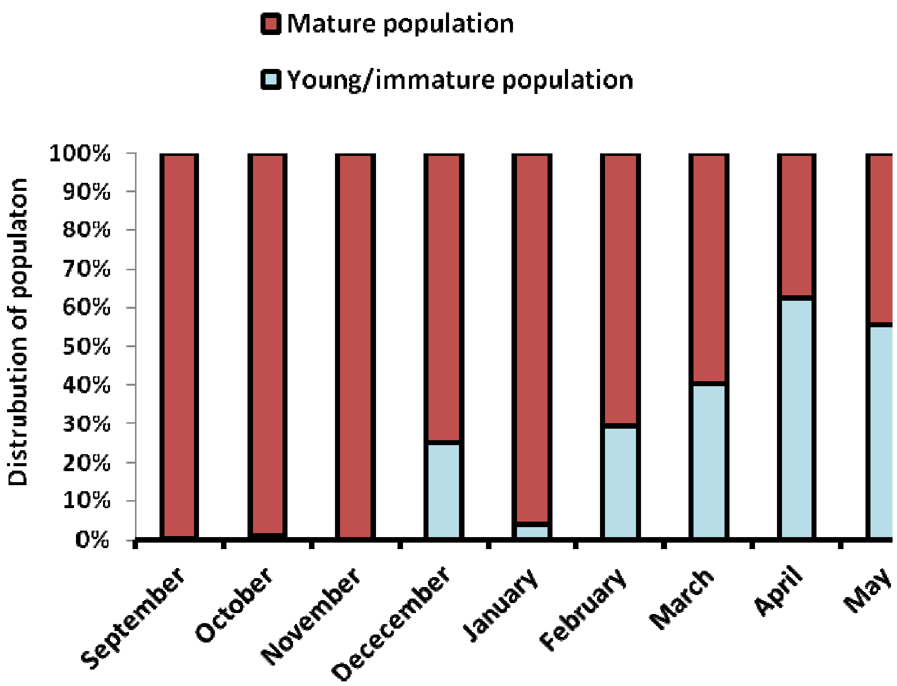
30
20
10
0
May/2010
N=290
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
Total length (cm)

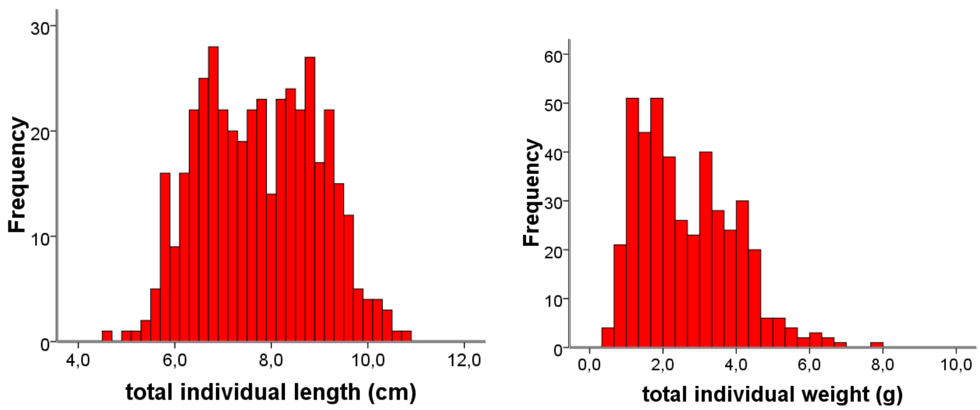


6.1.1.2.3. Monthly length frequency distribution of sprat population in Samsun Shelf Area, in 2010 (*sampling was done by commercial pelagic trawl*) (Zengin et al., 2011).



6.1.1.2.4. Monthly distribution of young and mature population of sprat in the Samsun Shelf Area in 2010 (*the reference point is length at first maturity that is suggested by Avşar, 1994*) (Zengin et al., 2011).

The length and weight frequency distributions were presented in fig 6.1.1.2.5. The mean length and body weight is found respectively 7.71±0.05 (4.6-10.7) cm, and 2.64±1.31 (0.51-7.86). The age range was determined as 1-5 years. The growth parameters were estimated as $L\infty$ = 13.04 cm, k =0.445 y^{-1} and t_0= -1.096 year and the constant and slope in length- weight relationship were calculated as 0,004 and 3,193 (R_{sq}= 0.95) respectively, for spring sampling 2012 (Fig.6.1.1.2.5.).



6.1.1.2.5. Length and weight frequency distributions of sprat for spring 2012 from Samsun shelf area (Turkey).

On the next figure (Figure 6.1.1.2.6.) the length-weight relationship of sprat from Turkish coast in 2012 was presented.

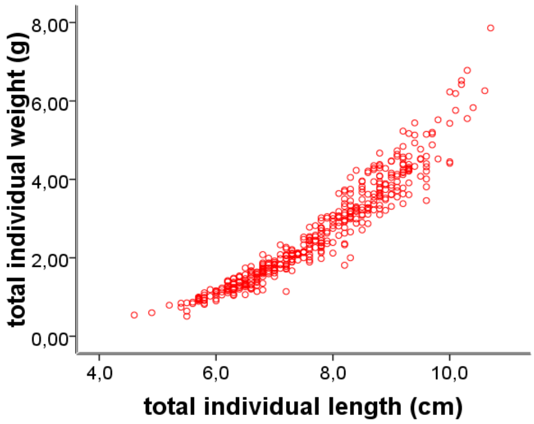


Fig. 6.1.1.2.6.. The age-length relationship in sprat for spring 2012 from Samsun shelf area.

6.1.1.3 *Maturity*

No maturity studies were conducted in 2012

6.1.2 Fisheries

6.1.2.1 *General description*

The sprat fishery is taking place in the Black Sea (GFCM Fishing Sub-area 37.4 (Division 37.4.2) and Geographical Sub-area (GSA) 29). The opportunities of marine fishing are limited by the specific characteristics of the Black Sea. The exploitation of the fish recourses is limited in the shelf area. The water below 100-150 m is anoxic and contains hydrogen sulphide. In Bulgarian. Romanian. Russian and Ukrainian waters the most intensive fisheries of Black Sea sprat is conducted in April till October with mid-water trawls on vessels 15- 40 m long and a small number vessels >40m. Beyond the 12-mile zone a special permission is needed for fishing. Harvesting of Black Sea sprat is conducted during the day when the sprat aggregations become denser and are successfully fished with mid-water trawls (Shlyakhov and Shlyakhova 2011; Shlyakhov *et al*.. 2012; Kumantsov and Raykov 2012). The use of paired vessels in pelagic trawling along Yesilirmak - Kizilirmak shelf area in southern Black Sea gained importance by 1990s and became wide spread by 2000s. At present nearly 40 pairs of vessels are operating along the mentioned area. The total catch of sprat -as a target species- is directly transported to fish meal and oil fabrics as raw material (Knudsen and Zengin 2006).

The significance of the sprat fishery in Turkey in the last three years has increased and the landings reached 87 141 t in 2011. In 2012 drastic decrease up to 12 092 has been observed. In contrast the catches in 2010 was 57 023 t which is close for the 5 years average value of the Turkish sprat catches in the Black Sea. The main gears used for sprat fishery in Turkey (fishing area is constrained in front of the city of Samsun) are pelagic pair trawls working in spring at 20 - 40m depth and in autumn - in deeper water: 40-80m depths. At the same time the Turkish pair-trawl fishermen used the same gear targeting horse mackerel and anchovy in the same area.

6.1.2.2 *Management regulations applicable in 2011 and 2012*

A quota (Table 6.1.2.2.1) is allocated in EU waters of the Black Sea (Bulgaria and Romania). No fishery management agreement exists among other Black Sea countries. In the EU Black Sea waters a global (both Romania and Bulgaria) TAC 12 750 tons has been allocated in 2009 and 2010. In 2011 and in 2012 allocated quota in Bulgarian waters was at the rate of 8 032.5 t sprat (Council Regulation 5/2012) and 3442.49 tfor Romanian waters .The decreasing trend in indices since 2008 was oserved despite of quotas regime in force in community waters. Because of insufficient national funding by NDCP hydroacoustic survey (2012) for the

assessment of sprat stocks in front of Bulgarian Black Sea coast not carried out.The data from hydroacoustic survey of sprat during the autumn survey in 2011 was added.From the catches of fish only the turbot species (*Scophthalmus maximus*) and sprat (*Sprattus sprattus*) are subject to quotas and are included in the National data collection program (NDCP). The applied quotas are precautionary because it is not possible their biomass to be calculated for the whole water basin of the Black Sea.

Table 6.1.2.2.1. EC quota and recommended Total allowable catch of sprat in EU waters for2008-2012.

Year / ***National data***	***2008***	***2009***	***2010***	***2011***	***2012***
Spicies	***Sprat (SPR)***	***Sprat (SPR)***	***Sprat (SPR)***	***Sprat (SPR)***	***Sprat (SPR)***
Quota. t	15 000[2]	12 750[2]	12 750[2]	11 475[2] 8032.5[1]	11 475[2] 8032.5[1]
Total catch. t	4 300.0363(BG) 234 (RO)	4 541.348 (BG) 92(RO)	4 039. 966 (BG) 39(RO)	3 957.895 (BG) 131.3 (RO)	3 156.832 (BG) 87.458(RO)
Biomass. t	32 718.33 60 000[5]	41 761.398[3] 60 000[5]	75 080.20[4] 59 600[5]	48 201.7[4] -	- 68 886[5]
Recommended TAC	average 13 746.57[3]	11 469.9[3]	12 500[4]	-	-

NB:[1] - *quota according to Regulation (EU) № 1579/2007. Regulation (EU) № 1139/2008. Regulation (EU) № 1287/2009. Regulation (EU) № 1004/2010. Regulation (EU) № 1256/2010. Regulation (EU) № 5/2012*

[2]*-EC's quota*

[3] *-Source of data: Institute of Oceanology – BAS. Bulgaria*

[4] *-Source of data: Institute of Oceanology – BAS. Bulgaria and NIMRD,Romania*

[5]*National Institute for Marine Research and Development. Romania*

Sprat fishery in Turkey was firstly promoted by the Commercial Fishery Advice of General Directorate of Fishery with date of 02.08.2002 and number of 24 834 regarding the years 2002-2004 (Section 2. Article 5) (Anonymous 2002). New management criteria were brought into force for sprat fishery. These criteria were summed up in four topics as:

(1) **Regulations about fishing area:** Sprat fishery by pelagic trawls should be conducted only along Samsun shelf area. The coordinates of this area were specified. But except sprat. the fishery was allowed for anchovy. horse mackerel and bluefish along other trawling areas in Black Sea.

(2) **Regulations about fishing gear:** In Turkey pelagic trawls operate as paired vessels. Vessels engaged in sprat fishery need to receive licence eligible only for one fishing period from Samsun City Directorate of Food. Agriculture and Livestock. The single vessel operation in pelagic fishery seems to be inconvenient for Turkey at least for now as the fisherman can quickly change the gear to bottom trawling during operation.

(3) **Regulations about time periods:** Though pelagic fishing period starts in 15 September as same as bottom trawling. it lasts to 15 May. Bottom trawling ends with 15 April. There is no limitation in distance from land for pelagic trawling.

(4) **Regulations about depth:** The pelagic fishery is banned in waters shallower than 18 m in fishing area between 15 September and 15 April. But between 15 April-15 May it is allowed in waters deeper than 36 m limited with offshore of Çayağzı Cape (Samsun-Yakakent) in west and Akçay estuary (Samsun - Ordu city border) in east (Anonymous. 2006). Sprat catch reaches a maximum in this one month-period and provide a great economic input for fishermen. Conversely with bottom trawling depth limitations are in force in pelagic fishery instead distance from land. But as mentioned above the depth limitation is increased to 36 m by 15 April in order to protect spawning adults and juveniles on coastal zone.

Table 6.1.2.2.2.Sprat TAC applied in Ukraine and Russian Federation in tons.

Year	Russian Federation	Ukraine
2005	42 000	60 000
2006		70 000
2007		40 000
2008	21 000	50 000
2009	21 000	50 000
2010	21 000	50 000
2011		60 000
2012		70 000

Table 6.1.2.2.3. Minimum landing size of sprat in the Black sea region

	BG	**GE**	**RO**	**RU**	**TR**	**UA**
Sprattus sparttus	TL=7cm	SL=6cm	TL=7cm	SL= 6cm	NO	SL=6cm

Legend: TL-total length; SL-standard length;

6.1.2.3 *Catches*

6.1.2.3.1 *Landings*

Catch and landings of the sprat in the Black Sea were reported by the Black Sea countries and data from Bulgaria and Romania were collected and reported for the Data Collection Program from National agencies for fisheries and aquaculture in both countries. Mid-water trawl (OTM) catches dominate the landings. Landings significantly decreased in the 2012 Turkey (from 87141 to 12092 t)but also a gradual decrease is reported by Bulgaria. Russian Federation and Ukraine). Romanian catches decreased to 88 tons in 2012 (Table 6.1.2.3.1.1).

Table 6.1.2.3.1.1. Sprat landings in the Black Sea.

year	Bulgaria	*Bulgaria	Romania	Ukraine	Turkey	Georgia	Russian Federation	Total
1970	1407		2678	353	0	0		4438
1971	2473		2517	846	0	0		5836
1972	2962		23	884	0	0	16	3885
1973	3383		22	878	0	0	22	4305
1974	4468		1245	477	0	0	23	6213
1975	5565		731	787	0	0	43	7126
1976	7199		161	1594	0	0	16	8970
1977	8754		1463	4346	0	0	2354	16917
1978	10596		149	1949	0	1	3317	16012
1979	13541		2269	36757	0	3466	17700	73733
1980	16568		989	47635	0	4571	14687	84450
1981	1888		2283	49175	0	5781	20165	79292
1982	16524		3004	3862	0	2462	15266	41118
1983	12023		3406	20755	0	886	3843	40913
1984	13921		4456	18021	0	847	5270	42515
1985	15924		6836	23657	0	1817	3365	51599
1986	1169		8979	33147	0	2939	7010	53244
1987	10979		9474	43158	0	697	8972	73280
1988	6199		6454	39835	0	7172	7157	66817
1989	7403		8911	63239	0	9708	16045	105306
1990	2651		3198	33174	0	6895	6955	52873
1991	1909		729	11094	0	2313	2675	17082
1992	2353	3266	2074	11492	0	830	3221	20883
1993	2174	3705	2439	9154	640	32	694	16664
1994	2200	3499.943	2203	12615	700	308	1013	20338.94
1995	2874	3199.948	1982	15218	157	288	1263	22107.95
1996	3535	3499.943	2014	20720	937	185	1537	28892.94
1997	3646	3645.94	3318	20208	468	85	706	28430.94
1998	3275	3274.946	3293	30282	1236	24	1243	39352.95
1999	3595	3594.941	1933	29238	421	45	4473	39704.94
2000	1737	3499.943	1803	32644	6225	42	5543	49756.94
2001	695	6961.121	1792	48938	1008	40	11122	69861.12
2002	11595	11595	1617	45430	1965	34	11218	71859
2003	9155	9154.6	1219	31366	5775	2	204	47720.6
2004	2889	7996.9	135	30891	5186	12	143	44363.9
2005	2575	6500	1487	35707	5271	19	1316	50300
2006	2655	8183.153	492	21308	6681		8157	44821.15
2007	2559	2984.59	208	18013	11725		6077	39007.59
2008	4304	4304	234	21111	39903		7814	73366
2009	4551	4551	92	24603	53385		8744	91375.48
2010	4041	4041	39	24652	57023		5839	91594
2011	3958	3958	131	24379	87141		5099	120707.8

2012	3157		88	15751	12092	3937	35024.86

* expert assessments

EWG 13-12 notes that the landings listed are largely consistent with the quantities submitted to JRC through the DCF 2012 Med and Black Sea data call.

6.1.2.3.2 *Discards*

No discards of sprat have been reported with the exception of Romanian reports giving figures of sprat discards. Such discards are very low.

6.1.2.4 *Fishing effort*

The following Tables 6.1.2.4.1 and 2 list the fishing effort data received from Member States through the official DCF data call in units of kW*days at sea and number of vessels. According to the first table 76% of the total sprat landings in Bulgarian marine area were realized by fleet segment 24<40 m LOA.In Romania only one fishing vessel using OTM targeting sprat has been operating in Black Sea. Major fishing gears used for sprat fishery were stationary uncovered pound nets.

Table 6.1.2.4.1. DCF nominal fishing effort (GT and *kw*days* at sea) associated to the LOA segments and % from the total catch as submitted to JRC through the DCF 2013 Med and Black Sea data call by major gear type 2007-2012 in Bulgaria.

LOA	31.12.2007			31.12.2010			31.12.2011			31.12.2012			Change in 2012 - 2007		
	vessels	GT	kW	vessels	GT	kW	vessels	GT	kW	vessels	GT	kW	vessels	GT	kW
0 < 6	845	601	6 594	762	546	5 943	773	554	5 987	805	582	6 507	-5%	-3%	-1%
6<12	1 595	3 464	42 173	1 471	3 199	39 925	1 464	3 164	39 730	1 466	3 129	39 444	-8%	-10%	-6%
12<18	66	1 273	8 625	67	1 308	9 275	62	1 200	8 403	64	1 227	8 853	-3%	-4%	3%
18<24	29	1 309	4 819	27	1 214	4 424	25	1 104	4 119	20	890	3 714	-31%	-32%	-23%
24<40	12	1 586	3 304	13	1 665	3 878	12	1 351	3 069	11	1 234	2 848	-8%	-22%	-14%
TOTAL	2 547	8 233	65 515	2 340	7 931	63 444	2 336	7 373	61 307	2 366	7 061	61 366	-7%	-14%	-6%

Table 6.1.2.4.2. DCF fishing effort (number of vessels) as submitted to JRC through the DCF 2012 Med and Black Sea data call by major gear type2012 in Bulgaria (A) and Romania (B)

YEAR	VESS_LENGTH	GEAR	MESH_SIZE_RANGE	FISHERY	AREA	NOMINAL_EFFORT	GT_DAYS_AT_SEA	NO_VESSELS
2008	VL0006	SB	00D14	MDPSP	SA 29	86279	7201	45
2008	VL0612	FPO	00D14	MDPSP	SA 29	16388855	155008	192
2008	VL1218	OTM	00D14	SPF	SA 29	1068620	146035	9
2008	VL1824	OTM	00D14	SPF	SA 29	808959	204422	4
2008	VL2440	OTM	20D40	SPF	SA 29	4251250	2025889	11
2009	VL0006	SB	00D14	MDPSP	SA 29	35948	6960	38
2009	VL0612	FPO	00D14	MDPSP	SA 29	12075037	1178437	169
2009	VL1218	OTM	00D14	SPF	SA 29	2957668	434558	15
2009	VL1824	OTM	00D14	SPF	SA 29	1440379	376387	5
2009	VL2440	OTM	20D40	SPF	SA 29	5520149	2650975	12
2010	VL0006	SB	00D14	MDPSP	SA 29	249121	27299	64
2010	VL0612	FPO	00D14	MDPSP	SA 29	18617358	1710535	188

2010	VL1218	OTM	00D14	SPF	SA 29	3559407	449947	6
2010	VL1824	OTM	00D14	SPF	SA 29	1306384	351630	7
2010	VL2440	OTM	20D40	SPF	SA 29	6995010	3003786	13
2011	VL0006	SB	00D14	MDPSP	SA 29	34136	3493	39
2011	VL0612	FPO	00D14	MDPSP	SA 29	740804	64139	87
2011	VL0612	OTM	00D14	MDPSP	SA 29	180869	15660	4
2011	VL1218	OTM	00D14	SPF	SA 29	5833424	827010	23
2011	VL1824	OTM	00D14	MDPSP	SA 29	856319	246060	5
2011	VL2440	OTM	20D40	SPF	SA 29	6172300	2718507	11
2012	VL0006	SB	00D14	MDPSP	SA 29	1649473	156317	124
2012	VL0612	FPO	00D14	MDPSP	SA 29	4694659	389268	104
2012	VL0612	OTM	00D14	MDPSP	SA 29	26822	2224	8
2012	VL1218	OTM	00D14	SPF	SA 29	7499190	1001555	26
2012	VL1824	OTM	00D14	MDPSP	SA 29	2080654	543064	12
2012	VL2440	OTM	20D40	SPF	SA 29	5570111	2511970	10

(A)

YEAR	VESSEL_LENGTH	GEAR	MESH_SIZE_RANGE	FISHERY	AREA	NOMINAL_EFFORT	GT_DAYS_AT_SEA	NO_VESSELS
2008	VL1824	OTM	14D16	MDPSP	SA 29	16560	5100	2
2008	VL1218	OTM	14D16	MDPSP	SA 29	2740	304	4
2008	VL0612	FPN	14D16	MDPSP	SA 29	72575	32256	13
2008	VL0006	FPN	14D16	MDPSP	SA 29	3198	410	4
2009	VL2440	OTM	14D16	SPF	SA 29	10592	4352	2
2009	VL0612	FPN	14D16	MDPSP	SA 29	113342	50377	17
2009	VL0006	FPN	14D16	MDPSP	SA 29	5429	714	7
2010	VL2440	OTM	14D16	SPF	SA 29	662	272	1
2010	VL0612	FPN	14D16	MDPSP	SA 29	102528	45546	14
2010	VL0006	FPN	14D16	MDPSP	SA 29	2624	100	3
2011	VL2440	OTM	14D16	SPF	SA 29	27158	8012	2
2011	VL2440	OTM	14D16	MDPSP	SA 29	4416	1290	1
2011	VL0612	FPN	14D16	MDPSP	SA 29	90236	26371	40
2011	VL0006	FPN	14D16	MDPSP	SA 29	1727	151	8
2012	VL2440	OTM	14D16	SPF	SA 29	23405	6837	1
2012	VL1218	FPN	14D16	DEMSP	SA 29	695	68	1
2012	VL0612	FPN	14D16	DEMSP	SA 29	195992	52100	27
2012	VL0006	FPN	14D16	DEMSP	SA 29	2394	199	4

(B)

6.1.2.5 *Commercial CPUE*

Commercial CPUE $kg.h^{-1}$has decreased in Bulgarian and Ukrainian waters in the 2010-2012. The same trend is detected for the 2010-2012 in Turkey sprat fishery. In Romanian waters a significant drop of CPUE has been observed due to drastic reduction of the fishing fleet (Figure 6.1.1.2.5.1).

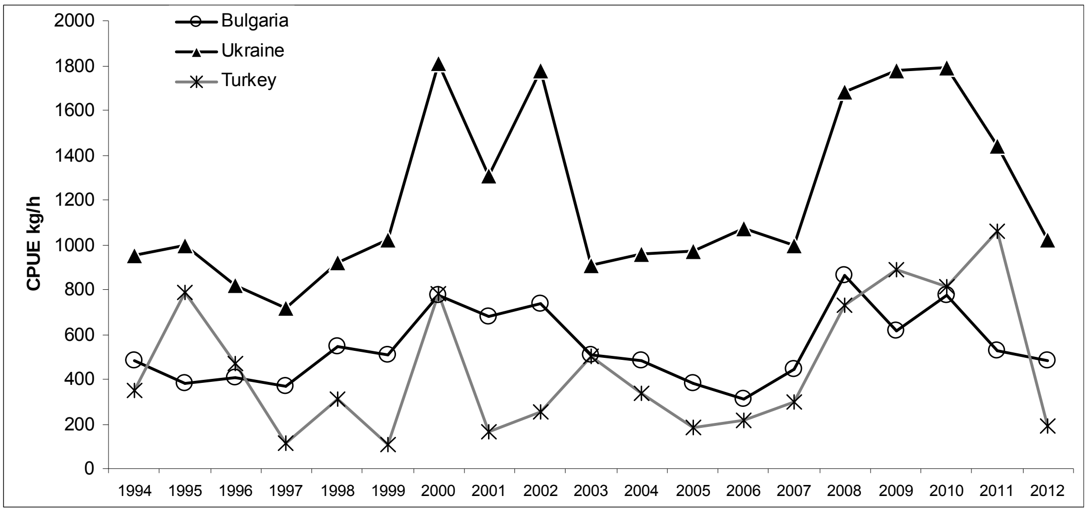


Fig. 6.1.1.2.5.1. CPUE $kg*h^{-1}$ derived from commercial fishery in Bulgaria. Ukraine and Turkey.

The main fishing gears targeting sprat in Bulgaria are OTM, FPO and BS. The distribution of CPUE to the corresponding fishing fleet segments are presented on Table 6.1.1.2.5.1.

Table 6.1.1.2.5.1. Average CPUE $kg.h^{-1}$of sprat caught by trawls. uncovered pound nets and beach seines in Bulgaria. 2012.

	Gear	Fleet segment	CPUE 2008	CPUE 2009	CPUE 2010	CPUE 2011	CPUE 2012
		LOA 0 - 6	422.44	49.79	150.94	63.5	104.21
	FPO	LOA 6 - 12	425	250.8	294.9	333.85	239.36
	GNS	LOA 6 - 12	--	--	--	118	119.98
		LOA 0 - 6	174.77	113.95	45.56	128.24	191.69
	SB	LOA 6 - 12	195.1	142	74.63	93.03	91.76
		LOA 6 - 12	107.8	142.2	241.25	128.29	--
		LOA 12 - 18	790	1356.25	1967.54	582.12	1151.53
		LOA 18 - 24	1418.84	1650.86	656.99	592.06	1127.35
SPR	OTM	LOA 24 - 40	2442.48	2457.01	2035.4	1846.63	1551.21

The Ukraine sprat fishing has been carried out by 16 fishing vessels from March to October 2012.

In the figure 6.1.1.2.5.2 are presented the official landings and effort in terms of vessel number in 1993-2012 in Samsun shelf area. The whole total landing is processed by fish oil and flour fabrics operating in the region.

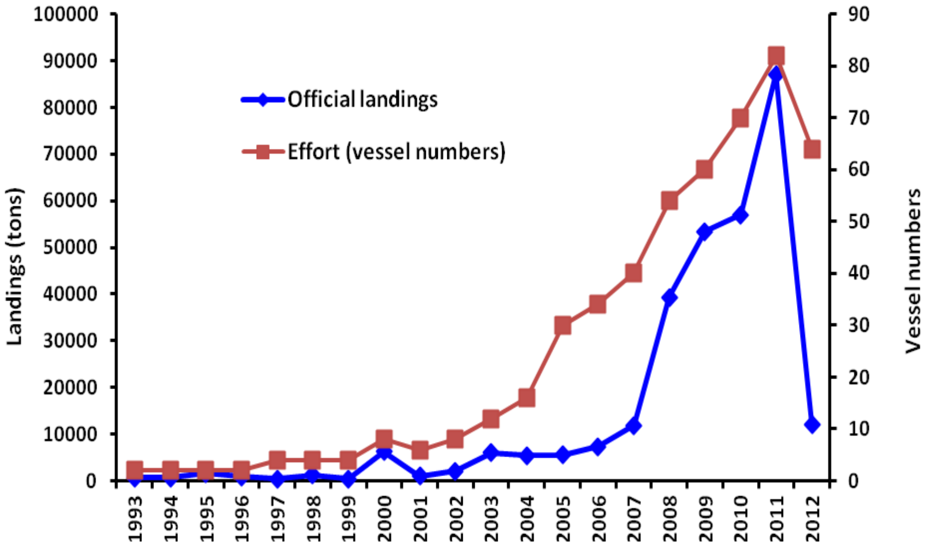


Figure 6.1.1.2.5.2 Data regarding the sprat landing and vessel number in 1993-2012 in Samsun shelf area.

The CPUE in the Turkish waters (Table 6.1.1.2.5.2.) increased in the last years as the highest level was reached in 2011 (for the long term period 1993-2012).

At present nearly 40 pairs of vessel licensed from Samsun and many others coming from western Black Sea. Istanbul. southern Marmara-Bandırma. and even from Aegean Sea; Izmir-Foça are operating along Samsun shelf area since pelagic fishery is much more profitable than bottom trawling. A great catch effort is emerged by this huge fleet starting by 2005/06, 2006/07, 2007/08 and especially by 2008/09. 2009/10 and 2010/11 fishing periods. But the sprat landing is sharply decreased in 2011/12 fishing season (Table 6.1.1.2.5.2). The sprat production tends to increase slightly by the beginning of 2000s. remarkably by 2006 and reaches nearly ten times by 2011. Trends in total catch were similar with the increase in vessel number. While total landing was about 1000-3000 tons at the end of 1990s (1997-1999). It was recorded as 50, 60 and 80 thousand tons at the last three fishing periods; 2008/09. 2009/10. 2010/11 and 2011/12 respectively (table 6.1.1.2.5.2).

Table 6.1.1.2.5.2. Data regarding sprat fishery fleet, total landings and CPUE (TUIK Fishery Statistics)

Years	**Total landing (tons)**	**No of vessels**	**CPUE (tons/year/vessel)**
1993	640	2	320.0
1994	700	2	350.0
1995	1570	2	785.0
1996	937	2	468.5
1997	468	4	117.0
1998	1236	4	309.0
1999	421	4	105.3

2000	6225	8	778.1
2001	1008	6	168.0
2002	2 050	8	256.3
2003	6 025	12	502.1
2004	5 411	16	338.2
2005	5 500	30	183.3
2006	7 311	34	215.0
2007	11 921	40	298.0
2008	39 303	54	727.8
2009	53 385	60	889.8
2010	57 023	70	814.6
2011	87 141	82	1062.7
2012	12091.7	64	188.9

Pelagic trawl vessels are generally 18-30 m in length. Though the number of vessels licensed for pelagic fishery is totally 120, only 64 of them actively operated in 2011/12 fishing period. Actually, the fleet is dynamic and the number of vessels operating on sprat changes in years. The smallest of these licensed vessels was 14.9 m and the biggest is 32.2 m. Mean length was estimated as 22.7 cm. 71.1% of vessels are over 20m length and the rest percent 28.3 are 19 m and below. The size distribution has a mode around 22 and 23 m lengths. Engine power ranges between 140 HP and 970 HP. The mean engine power of this fleet is approximated as 415.7 HP and the mode appears around 300 HP.

It is suggested that increase in spring months is possibly related with the vertical migration behaviour of sprat depending on season and sea water temperature (Zengin et al., 2002). Of the landed data in 2011 80% is obtained between March-May. The relative decrease in May is related with the fishery ban starting at 15 May. Of the total catch. 40% and 30% was landed in March and April respectively. Controversially, CPUE decreased to its minimum in winter. During the whole fishing period. the lowest catch was landed at the beginning of the period as 0.5% for November and 2% for December. The rate of total catch in January was 9.8% and 7.4% for February.

At 15 May though the catch is profitable by the alteration of legal fishery depth to 36m already 'tired" fisherman prefer to finish the fishery in the first week or up to 10th of May and took their vessels to ports for maintenance. However, CPUE was estimated as 1.8 ton/hour/vessel for May reflecting the general trend of spring season. The maximum CPUE was estimated as 2.2 ton/hour/vessel for March.

The sprat production tends to increase slightly by the beginning of 2000s, remarkably by 2006 and reaches nearly ten times by 2011.

The Features of Pelagic Fishery Fleet in Turkey

Pelagic trawl vessels are generally 18-30 m in length. The frequency distribution of sprat fishing vessels in size is presented in Figure 6.1.1.2.5.3 and the frequency distribution of engine power in Figure 6.1.1.2.5.4. Though the number of vessels licensed for pelagic fishery is totally 120. only 82 of them actively operated in 2011/12 fishing period.

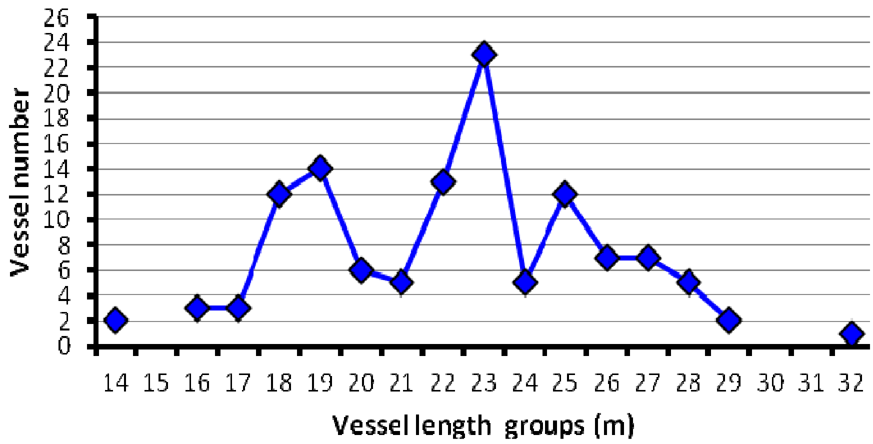


Figure 6.1.1.2.5.3. The frequency distribution of pelagic fishery vessels in size.

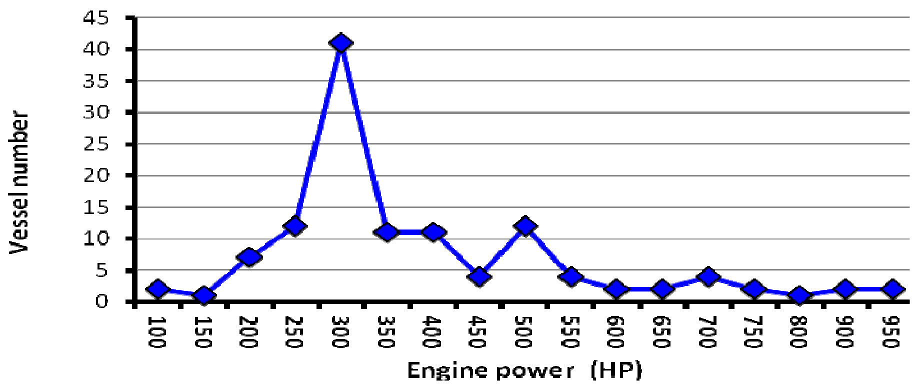


Figure 6.1.1.2.5.4. The frequency distribution of engine power in pelagic fishery fleet.

Actually. the fleet is dynamic and the number of vessels operating on sprat changes in years.

The smallest of these licensed vessels was 14.9 m and the biggest is 32.2 m. Mean length was estimated as 22.7 cm. 71.1% of vessels are over 20m length and the rest percent 28.3 are 19 m and below. The size distribution has a mode around 22 and 23 m lengths. Engine power ranges between 140 HP and 970 HP. The mean engine power of this fleet is approximated as 415.7 HP and the mode appears around 300 HP.

Table 6.1.1.2.5.4. CPUE *kg/h* *1000 of Ukrainian fishing vessels. 1996-2012 (Shlyakhov *et al*.. 2012)

Ukrainian commercial fleet CPUE kg*h-1 by years and quarters					
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	average
1996	0.41	0.96	1.27	0.64	820
1997	0.36	0.84	1.11	0.56	720
1998	0.46	1.08	1.42	0.72	920
1999	0.5	1.2	1.58	0.8	1020
2000	0.85	2.22	2.8	1.41	1820
2001	0.65	1.55	2	1.03	1310
2002	0.85	2.12	2.75	1.39	1780
2003	0.45	1.1	1.45	0.65	910
2004	0.4	1.2	1.5	0.75	960
2005	0.48	1.1	1.55	0.75	970
2006	0.5	1.25	1.67	0.85	1070

2007	0.45	1.2	1.55	0.8	1000
2008	0.83	2	2.6	1.3	1680
2009	0.85	2.1	2.75	1.4	1780
2010	0.8	2.15	2.8	1.4	1790
2011	0.55	1.77	2.17	1.15	1440
2012	240	1580	1710	550	1020

6.1.3 Scientific Surveys

6.1.3.1 *Method 1 Pelagic survey in EU watres*

Stratified sampling methodology was applied in Bulgarian (for the period of 2007-2010 by Raykov *et al.* 2007; Raykov. 2008; Raykov *et al*.. 2008;Raykov *et al*.. 2009; Raykov *et al*.. 2010; Raykov *et al*., 2011; Raykov et al., 2013). and Romanian waters (Radu *et al*.. 2010a; Radu *et al*.. 2010b; Radu *et al*.. 2010c).Taking into account exact depths (isobaths). The whole area was divided to sub areas "strata" depending on depth: first stratum 15-35 – second 35- 50 m.. third 50-75m. and fourth 75-100m. The examined area was divided into equal sized fields - with total number 55; each sector equal to about 63 $км^2$ (5' Lat. × 5' Long.). The trawling activities were carried out in meridian direction. The duration of each haul was 60 min; average velocity 2.8 knots (5.19 km* h^{-1}). Biological data collection using mid-water trawl supply scientists with valuable information of population parameters such as size. age. sex composition. condition (Fulton's coefficient) and relative indices of abundance used in tuning later in the analysis. The CPUE derived from pelagic surveys was used for tuning series in the ICA for sprat.

No pelagic surveys have been conducted in 2012 in EU waters.

6.1.3.2 *Method 1 Hydroacoustic survey in EU watres*

The acoustic survey was accomplished under National Data Collection Programs of Bulgaria and Romania for 2011 during the period 15th November – 6th December 2011 with duration of 20 working. The survey covers partially the territorial waters and EEZ of Bulgaria and Romania in FAO GSA 29 – Black Sea. The study area includes continental shelf and slope up to 2000 m in front of Bulgarian and Romanian coasts. The design for the acoustic sampling was adapted to the characteristics of the spatial structures of small pelagic fish in the Black Sea as well as the peculiarities in the topography. The survey design includes parallel transects. perpendicular to bathymetry with inter-transect distance of 5 nm to achieve the minimization of the coefficient of variation of the acoustic estimates for the target species (Panayotova *et.al*. 2012).

The target species of the survey were European sprat (*Sprattus sprattus*) and whiting (*Merlangius merlangus*).The echo partitioning into species was based on echogram visual scrutinisation. This was done either by direct allocation based on the identification of individual schools and allocation on account of representative fishing stations. Following the results from the survey. abundance indices of the species sprat. whiting and horse mackerel were estimated by 3 strata (Panayotova et.al., 2012). Asaresultfrom fishing hauls. mono-specific catches were observed in 89.47 % of hauls. composed by sprat over 75% of total weight (Panayotova et.al. 2012). Estimated relative sprat biomass is 48 201.70 t in the investigated area. from which biomass of mature fish amounts of 48 173.18 t (Panayotova et.al., 2012) – Table 6.1.3.1.1.

Table 6.1.3.2.1 Estimated relative biomass (tones) of sprat by age groups and polygons. November - December 2011.

Polygon	**Total (t)**	**Age**				
		0	**1**	**2**	**3**	**4**
1	8827.96		2807.42	4576.26	1444.28	
2	30776.65	24.83	11696.45	15123.44	3898.82	33.11

3	8597.092	3.69	4523.81	3526.73	542.86	
Total	**48201.70**	**28.52**	**19027.68**	**23226.43**	**5885.96**	**33.11**

No hydroacoustic surveys have been conducted in EU waters in 2012.

6.1.3.2.1 *Geographical distribution patterns*

The data regarding georgraphical distribution were obtained from pelagic survey conducted in Romanian marine area of the Black Sea in autumn period.

To estimate the biomass of the main agglomerations of caught fish species with commercial value, trawlers survey was executed in the Romanian continental platform, and it were also used the data obtained from industrial trawlers. The evaluation of a part of the sprat stock (fishing agglomerating) was done through a holistic method of trawlers survey (surface method), which can be applied in small areas, without taking into account the distribution of the entire stock and uses as parameters: vessel speed, horizontal trawl opening and trawlers time.

In the 33 trawlers poll conducted on an area of 2 855.77 Nm^2; the distribution of sprat agglomerations was different. The average values of the sprat catches, were contained in the limits between 19.72 t/Nm^2 and 21.37 t/Nm^2. Significant catches were recorded between 30 and 60 m isobates, in the Periboina - St. Gheorghe and Constanta - Mangalia. In autumng survey, the researched area of 2 855.7 Nm^2, sprat biomass was estimated at 68 887 tons (table 6.1.3.2.1.1.; figure 6.1.3.1.1.1.).

Table 6.1.3.2.1.1. Results from 'swept area' methodology application in Romanian Black Sea waters, Nov-Dec 2012.

Depth range (m)	***0 - 30m***	***30 – 50m***	***50-70 m***	***Total***
Investigated area (Nm^2)	754.58	1294.12	807	2855.7
Variation of the catches (t/Nm^2)	0.16-56.75	0.45-52.57	0.51-35.33	0.17-56.75
Average catch (t/ Nm^2)	19.72	21.37	8.99	
Biomass of the fishing agglomerations (t)	14887.57	27654.83	7255.52	49797.92
Biomass extrapolated the Romanian shelf (t)				**68887**

Relative biomass distribution of sprat from scientific survey (Nov-Dec 2012) in Romanian waters were presented on fig.6.1.3.1.1.1.

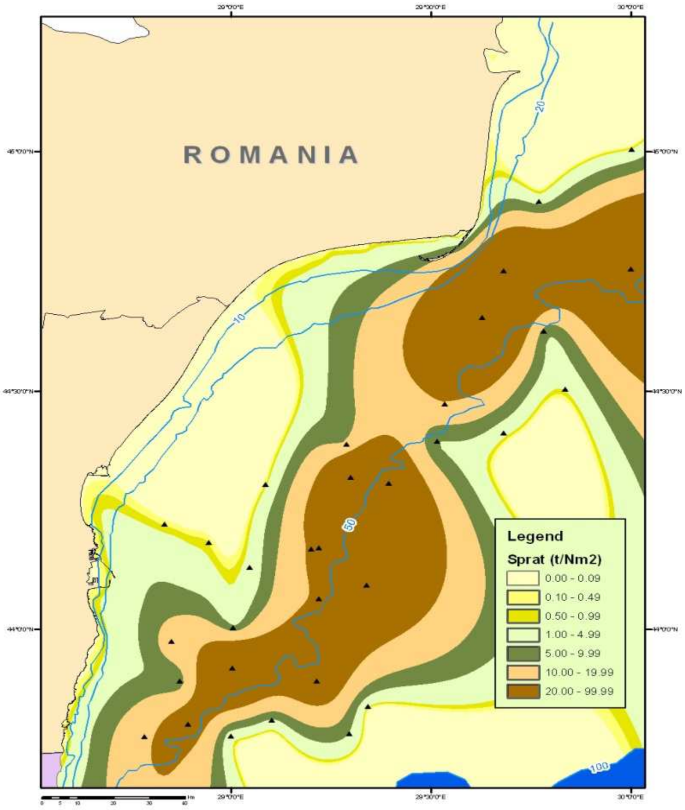
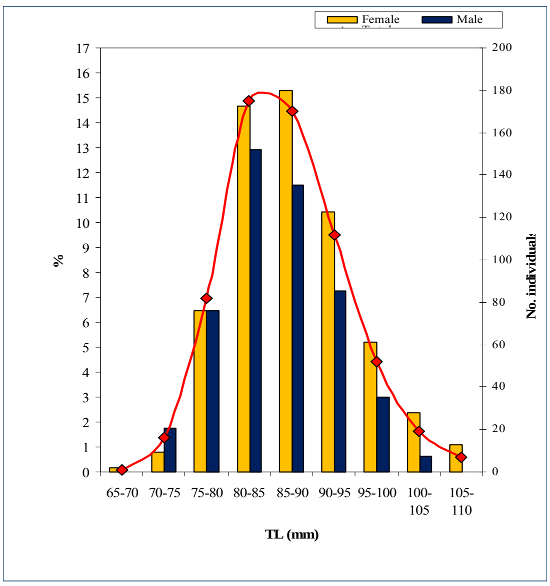
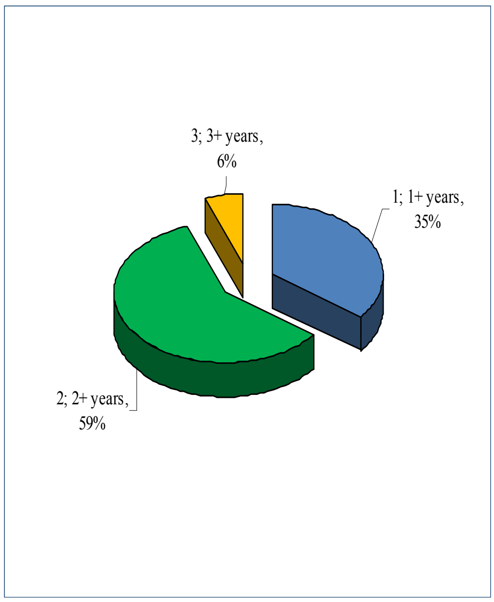


Figure 6.1.3.1.1.1. Distribution map of sprat relative biomass along Romanian coast obtained during the pelagic survey in November – December 2012.

6.1.3.2.2*Trends in abundance at length or age*

Due to change in the fishing gear and method for stock assessment for sprat in 2011 we were unable to compare abundance indices with the previous assessments (in line with the previous indices derived in pelagic trawl surveys).





(A) (B)

Figure 6.1.3.1.2.1. (A) Length distribution of Sprat (*Sprattus sprattus*) by hauls during acoustic survey along Romanian coast in 2012 (B) Age distribution of Sprat (*Sprattus sprattus*) by hauls during acoustic survey along Romanian coast in 2012.

Size structure of sprat catches during the survey encompasses fish with total lengths between 5 and 11 cm. Two maxima of abundance in length classes were distinguished - in 8 cm and 8.5 cm. which correspond mainly to age groups 1 and 2 – Fig. 6.1.3.1.2.1. The average length of all measured fish over all hauls was estimated at 8.4 cm.

6.1.3.2.3 *Trends in growth*

Length has bimodal distribution in terms of (80-85mm) and (85-90mm). Sub dominated are the ranges 95-100mm.

6.1.3.2.4 *Trends in maturity*

No trends in maturity were estimated and no analyses were conducted in 2012.

6.1.3.2.5 *Abundance and biomass*

Estimated abundance and biomass of sprat in the Turkish Black Sea area (Zengin and Gumus 2012) are presented in Table 6.1.3.2.5.1.

Composition of CPUE

The mean catches per unit effort (CPUE) and abundance index (CPUA) is estimated respectively as 1289.59 kg/km^2 and 1101.54 kg/km^2 in trawl samplings conducted between 40-80 m (minimum 32.8 m, maximum 109.8 m) depths along Samsun shelf area between January and May 2012. Abundance indices were estimated by 'swept area method' for the period of sprat fishing seasons (January-May) from commercial vessels (6.1.1.2.5.6.) (Sparre and Venema, 1992). The individual experience of fisherman and the quality of technical equipment of the vessel are determinative in the amount of daily catch. Sprat catch reaches its maximum especially in spring months; especially between March-May. But showed that the same decreasing CPUE and CPUA comprising between 2011 and 2012. The mean catches per unit effort (CPUE) and abundance index (CPUA) is calculated respectively as 4437.75 kg/km^2 and 4184.85 kg/km^2 in 2011. It is compared two last years, the 2011 indices about 3.5 time than high in 2012 (Table 6.1.3.2.5.1.).

Table 6.1.3.2.5.1.Descriptive data regarding (kg/h) and abundance indices (kg/km^2) of sprat for 2011 and 2012 in the Samsun shelf area (SSA).

Years	No of hauls	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CPUE/2011	14	1454.55	14857.14	4437.75	-	-
CPUA/2011	14	820	15917.09	4184.85	-	-
CPUE/2012	126	57.14	3130.43	1289.59	60.23	676.11
CPUA/2012	126	55.51	2721.90	1101.54	54.08	607.08

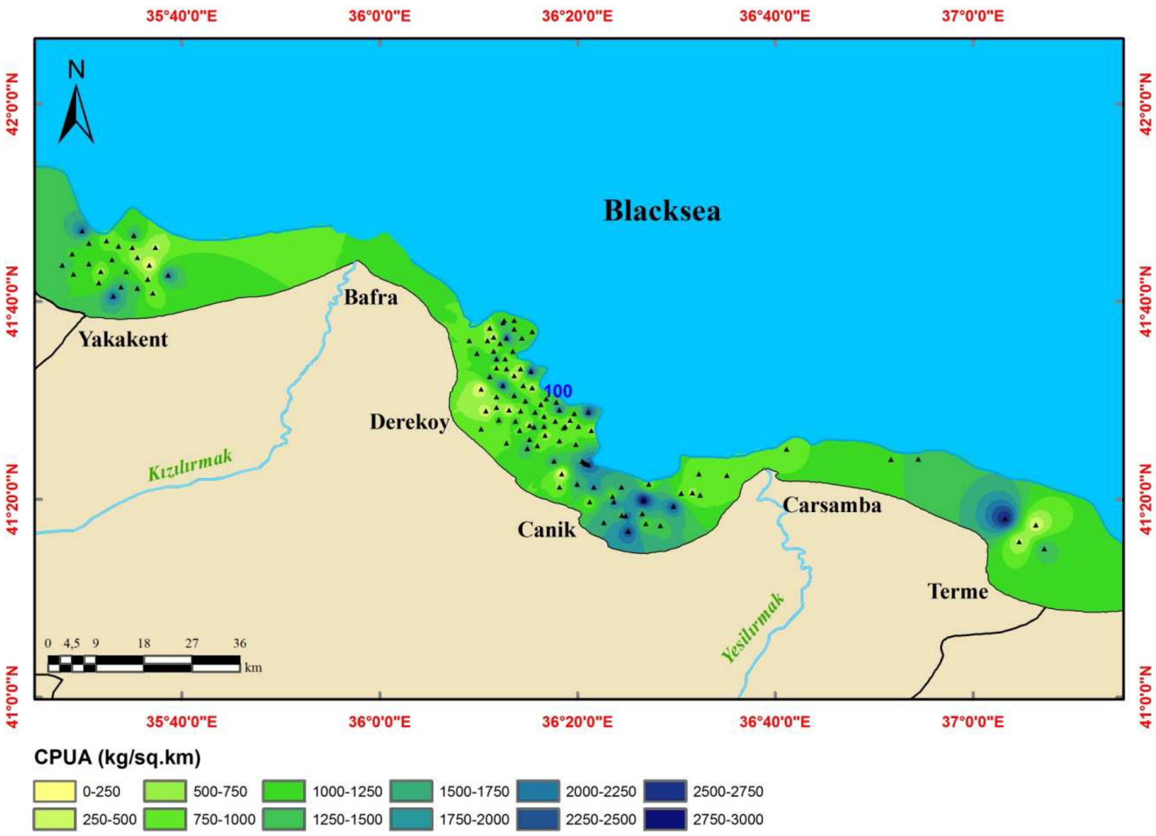


Figure 6.1.1.2.5.6. Map of the sprat biomass indices in the Samsun Shelf Area, 2012 (This mapping is coverage all data).

6.1.4 Assessment of historic parameters

6.1.4.1 *Method 1: ICA*

6.1.4.1.1 *Justification*

We used Integrated Catch-at-age Analysis (ICA; Patterson and Melvin. 1996). ICA is a statistical catch-at-age method based on the Fournier and Deriso models (Deriso et al.. 1985). It applies a statistical optimization procedure to calculate population numbers and fishing mortality coefficients-at-age from data of catch numbers-at-age and natural mortality. The dynamics of a cohort (generation) in the stock are expressed by two non-linear equations referred to as a survival equation (exponential decay) and a catch equation:

$$N_{a+1.y+1} = N_{a.y} * exp(-F_{a.y} - M).$$

$$C_{a.y} = N_{a.y} * [1 - exp(-F_{a.y} - M)] * F_{a.y} / (F_{a.y} + M).$$

where C. N. M. and F are catch. abundance. natural mortality. and fishing mortality. respectively. and a and y are subscript indices for age and year.

The algorithm initially estimates population numbers and fishing mortality fitting a separable model. when F is assumed to conform to a constant selection pattern (fishing mortality-at-age). but fishing mortality by year is allowed to vary. The F matrix is then modelled as a multiplication of the year-specific F and the specified selection pattern. This procedure substantially diminishes the number of parameters in the model.

In its second stage. the ICA algorithm minimizes the weighted Sum of Square Residuals (SSR) of observed and modelled catch and relative abundance indices (CPUE). assuming Gaussian distribution of the log residuals:

$$min\ [\textstyle\sum_{\boldsymbol{a.y}} pc_{a.y} (log\ C_{a.y} - log\ \hat{C}_{a.y})^2 + \sum_{\boldsymbol{a.y.f}} pi_{a.f} (log\ I_{a.y.f} - log\ \hat{I}_{a.y.f})^2.$$

where C. Ĉ. I. and Î are observed and estimated catch and age-structured index. respectively. and a. y. and f are subscript indices for age. year. and fleet. respectively. Weights associated with catches and different indices (pc. pi) are ideally set equal to the inverse variances of catch and index data. and can be calculated based on the residuals between modelled and observed values. However. weights are usually set by the user on the basis of some information about the reliability of different indices and current experience with modelling the stock. Indices are defined as related to population numbers by the equations:

$$\hat{I}_{a.y} = N_{a.y} {*} exp(-F_{a.y} - M)$$

$$\hat{I}_{a.y} = q_a {*} N_{a.y} {*} exp(-F_{a.y} - M)$$

$$\hat{I}_{a.y} = q_a {*} (N_{a.y} {*} exp(-F_{a.y} - M))^k{}_a\ .$$

The two unknown parameters (qa. an age-specific catchability. and k. a constant) are estimated according to the assumed relationship between the population and the abundance index. which has to be specified as being one of the above – identity. linear. or power. respectively.

ICA combines the power and accuracy of a statistical model with the flexibility of setting different options of the parameters (e.g. a separable model accounting for age effects) and for this raison is suitable for a short living species (age 5 at maximum) such as the Black Sea sprat. ICA has previously been applied to Black Sea sprat by Daskalov (1998) and Daskalov et al. 2010, 2011, and 2012.

6.1.4.1.2*Input parameters*

Catch and weight at age. natural mortality. and 4 age structured indices are used to run ICA (Table 6.1.4.1.2.1).

Total catch at age data were compiled by summing catch at age matrices from Bulgaria. Romania. Russia. Turkey and Ukraine. Catch at age matrix from Russia was derived by applying age composition and mean weight in the catch of Ukraine to Russia catch. Tuning index from the Bulgarian Pelagic Trawl Survey (PTS) was applied for 2007-2011 (Table 6.1.4.1.2.1).

Table 6.1.4.1.2.1 Imput parameters for ICA

```
Output Generated by ICA Version 1.4
 ------------------------------------

        SPRAT 2011
        ----------

        Catch in Number
        ---------------
------+----------------------------------------------------------------------------------------------------------------
AGE   |    1992    1993    1994    1995    1996    1997    1998    1999    2000    2001    2002    2003    2004    2005    2006
------+----------------------------------------------------------------------------------------------------------------
  0   |     51.    255.    115.     21.    108.    278.    236.   1009.    406.    809.    415.   1202.    445.    528.   1158.
  1   |   2673.   2673.   2072.   1712.   2496.   2741.   2278.   3838.   4877.  10352.   6829.   5654.   6878.   6024.   5976.
  2   |   2114.   1453.   2182.   2792.   2773.   2600.   2831.   3086.   3340.   6646.   7655.   5454.   3580.   4652.   2705.
  3   |    528.    218.    442.    418.    579.    830.   1741.   1302.   1313.   1269.   3090.   3024.   2666.   1602.    785.
  4   |     96.     14.     13.     13.     17.     43.     82.    121.    110.    109.    182.    674.    278.    372.     92.
  5   |      7.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
------+----------------------------------------------------------------------------------------------------------------
       x 10 ^ 6

        Catch in Number
        ---------------
------+----------------------------------------
AGE   |    2007    2008    2009    2010    2011
------+----------------------------------------
  0   |   3180.   1299.   1558.   2934.   2581.
  1   |   5351.   7774.  12266.   7940.  10080.
  2   |   1876.   3248.   7833.   7120.  12677.
  3   |    802.   1327.   3278.   4378.   8236.
  4   |    113.    168.    369.    316.    377.
  5   |      0.      0.      0.      6.     14.
------+----------------------------------------
       x 10 ^ 6


        Predicted Catch in Number
        -------------------------
```

AGE	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	656.	857.	747.	1132.	1056.	1233.	1367.	1826.	1656.	2581.
1	6528.	5268.	4539.	5935.	4800.	4652.	7085.	14947.	11706.	15319.
2	6084.	6716.	3511.	4407.	3083.	2771.	3610.	9828.	11243.	11237.
3	3241.	3188.	2187.	1630.	1064.	917.	1168.	2548.	3304.	4241.
4	172.	529.	297.	311.	105.	90.	117.	269.	246.	377.

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	.001700	.001700	.002300	.002500	.002500	.002300	.002400	.002800	.002300	.001700	.001800	.001700	.001900	.002100	.002000
1	.002100	.002500	.003400	.003800	.003800	.003300	.004000	.003200	.003500	.002500	.002700	.002800	.002900	.003500	.003300
2	.004500	.003600	.004000	.004600	.005200	.004900	.005100	.005000	.004500	.004000	.004100	.004000	.004400	.004700	.004300
3	.006800	.006000	.004700	.005400	.006000	.006300	.007600	.006500	.006000	.006300	.005800	.006100	.006000	.006200	.006000
4	.008600	.007700	.007700	.006900	.007400	.007200	.009400	.007300	.007800	.006900	.007700	.006800	.007300	.007700	.007300
5	.010800	.010800	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000

Weights at age in the catches (Kg)

AGE	2007	2008	2009	2010	2011
0	.001700	.002300	.002400	.002100	.002100
1	.003300	.003400	.003100	.002900	.002700
2	.004900	.004300	.004000	.004400	.003700
3	.007200	.005200	.004900	.006500	.004600
4	.008700	.007000	.006000	.008000	.008700
5	.010000	.010000	.010000	.016000	.000000

Weights at age in the stock (Kg)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	.001700	.001700	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000
1	.002100	.002500	.003500	.003300	.002800	.002700	.003400	.002500	.003200	.003500	.003600	.003500	.003400	.003600	.003600
2	.004500	.003600	.004100	.004300	.004300	.004700	.004600	.004700	.004400	.004400	.004500	.004400	.004400	.004600	.004600
3	.006800	.006000	.004800	.004800	.004700	.005700	.006400	.005900	.005600	.005200	.006100	.005900	.006000	.006100	.005700
4	.008600	.007700	.006200	.005500	.005300	.006900	.008200	.007300	.007200	.006700	.007400	.007400	.007200	.007400	.007400
5	.010800	.010800	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000

Weights at age in the stock (Kg)

AGE	2007	2008	2009	2010	2011
0	.001000	.001000	.001000	.001000	.001000
1	.003600	.003100	.003100	.002500	.003000
2	.004700	.004200	.004100	.003500	.004000
3	.006300	.005600	.004700	.004500	.004800
4	.007600	.007000	.005400	.007100	.007300
5	.010000	.010000	.010000	.016000	.010000

Natural Mortality (per year)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000
1	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
2	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
3	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
4	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
5	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000

Natural Mortality (per year)

AGE	2007	2008	2009	2010	2011
0	0.64000	0.64000	0.64000	0.64000	0.64000
1	0.95000	0.95000	0.95000	0.95000	0.95000
2	0.95000	0.95000	0.95000	0.95000	0.95000
3	0.95000	0.95000	0.95000	0.95000	0.95000
4	0.95000	0.95000	0.95000	0.95000	0.95000

5	0.95000	0.95000	0.95000	0.95000	0.95000

Proportion of fish spawning

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	2007	2008	2009	2010	2011
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

AGE-STRUCTURED INDICES

Bul

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	9.78	19.59	41.06	53.32	52.36	101.06	96.51	87.64	69.14	73.95	80.74	58.86	73.12	65.32	77.50
2	57.49	48.77	38.16	28.37	58.52	30.60	68.95	60.47	66.09	64.79	54.65	38.78	38.98	37.62	70.25
3	16.27	7.36	9.45	6.21	5.28	4.54	6.28	3.43	21.45	18.67	19.65	13.08	7.58	11.60	50.73
4	0.25	0.23	0.59	0.61	0.54	0.30	0.61	0.20	1.16	3.34	4.85	1.31	2.35	1.98	5.04

x 10 ^ 3

Bul

AGE	2009	2010	2011
1	125.36	81.34	57.04
2	109.76	88.80	62.24
3	37.33	68.20	45.51
4	5.98	7.80	6.75

x 10 ^ 3

Ukr

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	124.38	80.94	111.12	58.09	59.67	97.40	222.49	193.27	158.30	76.22	125.47	113.57	180.31	127.15	284.84
2	74.90	103.68	118.27	50.40	68.14	85.43	146.35	118.28	179.30	76.02	46.40	88.14	69.18	24.19	55.49
3	8.05	9.43	9.43	10.52	46.52	37.49	66.40	22.53	76.56	47.52	54.76	29.98	24.67	16.90	37.53
4	0.51	0.14	0.66	0.72	2.36	0.56	6.10	2.15	4.65	10.87	5.06	8.06	2.52	0.10	3.07

x 10 ^ 3

Ukr

AGE	2009	2010	2011
1	335.38	352.09	253.76
2	143.30	67.33	70.76
3	37.47	4.84	14.37
4	0.66	0.24	0.11

x 10 ^ 3

Bul survey

AGE	2007	2008	2009	2010
1	19352.	44034.	55081.	88238.

```
  2   |  30667.  40393.  55722.  84987.
  3   |  25733.  12928.  40543.  53350.
  4   |    999.   1081.   9585.    749.
------+------------------------------
```

6.1.4.1.3*Results*

ICA was run assuming a constant selection pattern in 2002-2011 (Fig. 6.1.4.1.3.1.Table 6.1.4.1.3.1) with reference F at age 2 and Selection at the last 'real' age (S4) equal 1.

The results of the ICA show a reasonable agreement with tuning data (Fig. 6.1.4.1.3.3. Fig. 6.1.4.1.3.4. Fig. 6.1.4.1.5.). The overall fit and partial SSR converged to unique minima (Fig. 6.1.4.1.3.6).

The analysis of the main population parameters (abundance. catch. fishing mortality. Fig. 6.1.4.1.3.6. Table 6.1.4.1.3.1.) shows that the sprat stock has recovered from the depression in the 1990s due to good recruitment in 1999-2001 and the biomass and catches have gradually increased over the 1990s and during the 2000s reached levels comparable to the previous period of high abundance 1975-1989 (Fig. 6.1.4.1.3.8). The stock estimates reveal the cyclic nature the sprat population dynamics. The years with strong recruitment were followed by years of low to medium recruitment which leads to corresponding changes in the the Spawning Stock Biomass (SSB). High fishing mortalities (F_{1-3}) were observed during the stock collapse in the early 1990s. in 2004-2005. and 2009-2011. In 2011 the highest ever total catch of 120 708t (Table 6.1.2.3.1.1) was recorded due mainly to the intensive development of the Turkish sprat fishery. Over 2007-2011 years the levels of biomass and catches were comparable with the highest figures reported, but in 2009-2012 - a decreasing trend in recruitment becomes evident (Fig. 6.1.4.1.3.6.). In the last year catches dropped more than 3 times, and SSB is estimated at the level of 2004-2006 i.e. about 200 000t. Due to lower catches average fishing mortality also dropped from 1.12 in 2011 to 0.404 in 2012.

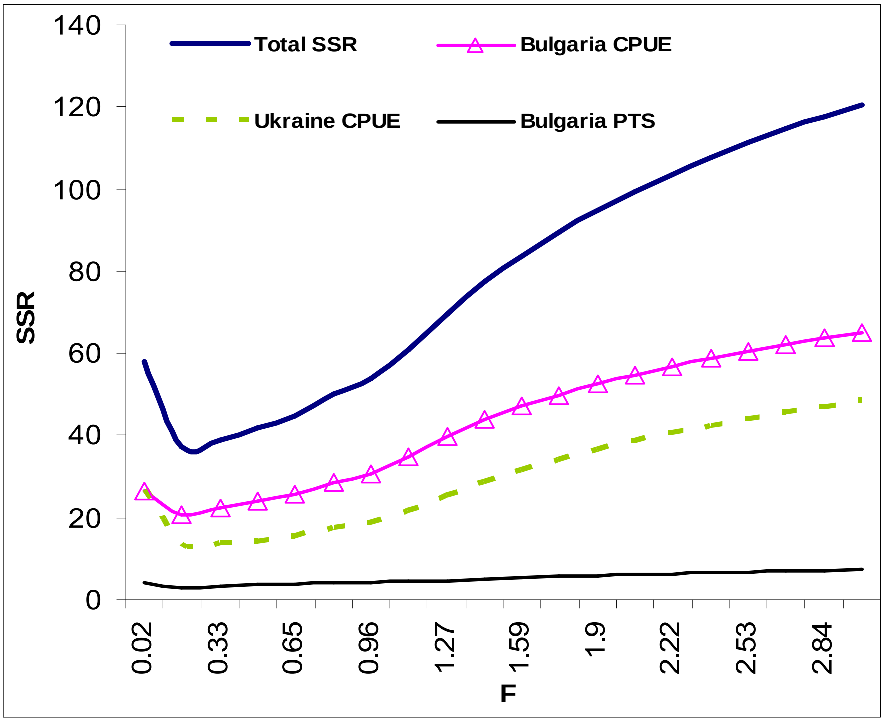


Fig. 6.1.4.1.3.1. Trajectories of the total Sum of Squared Residuals (SSR) and the partial SSRs of the two tuning fleets as functions of the reference F.

Fig. 6.1.4.1.3.2. Selection pattern estimated by the separable model

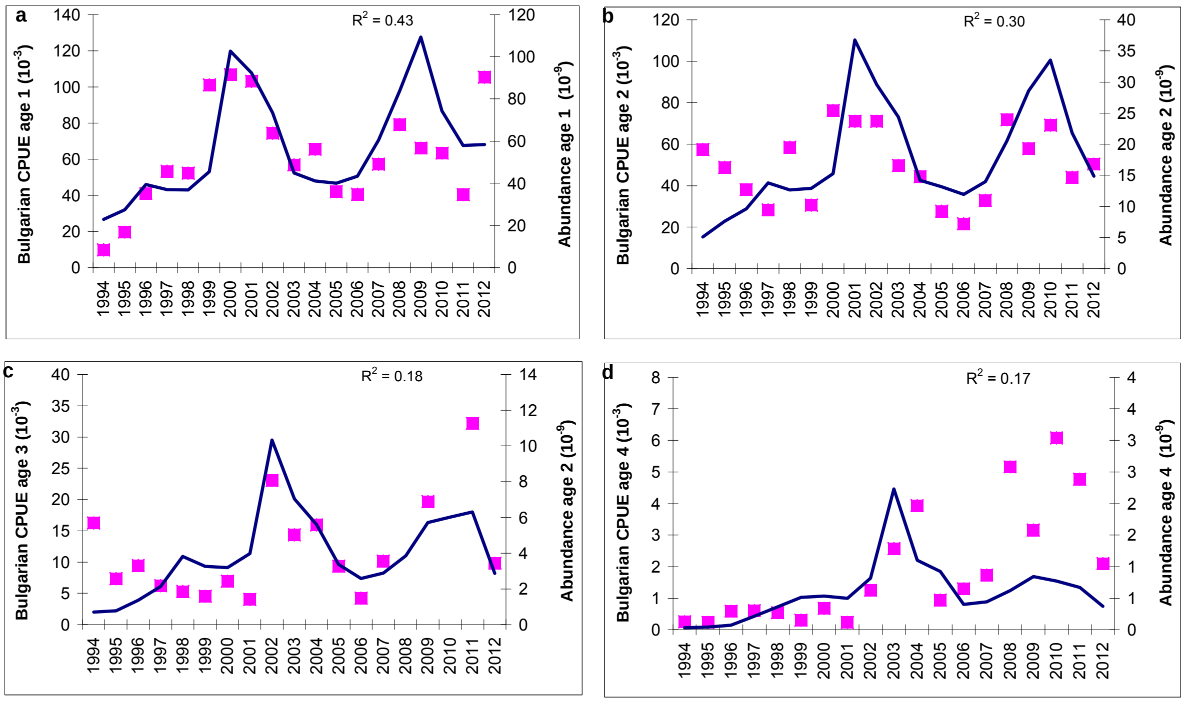


Fig. 6.1.4.1.3.3. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Bulgarian CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3. (d) Age 4.

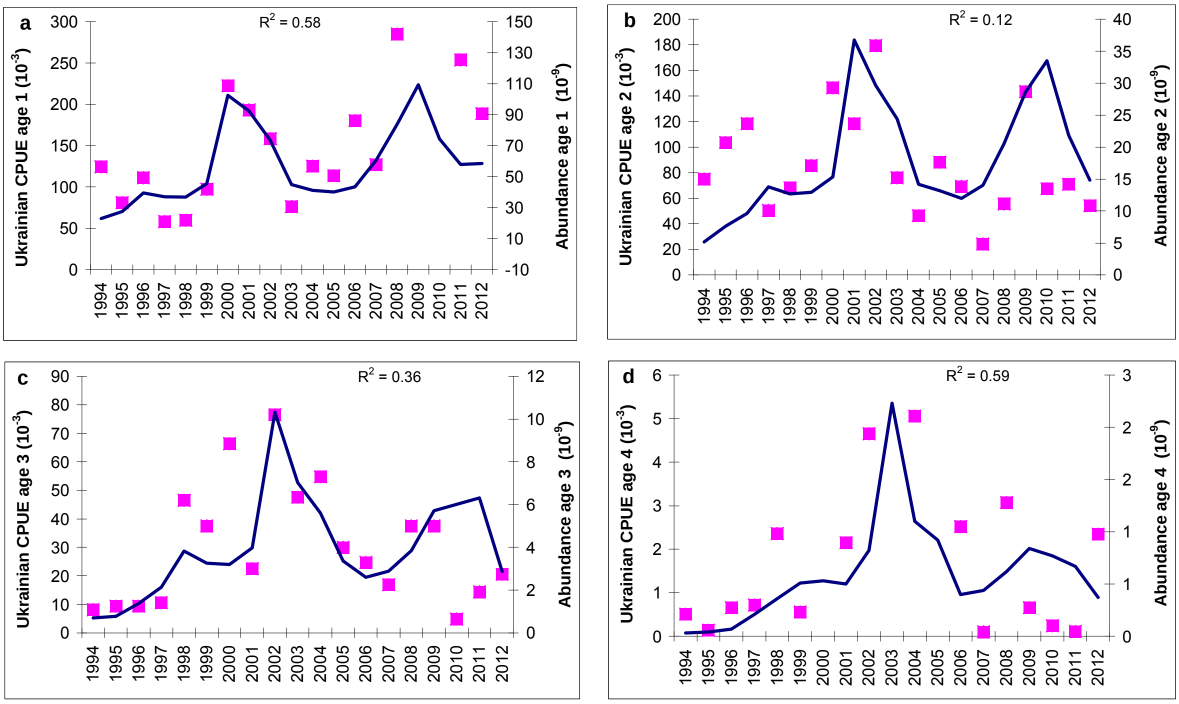


Figure 6.1.4.1.3.4. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Ukrainian CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3. (d) Age 4.

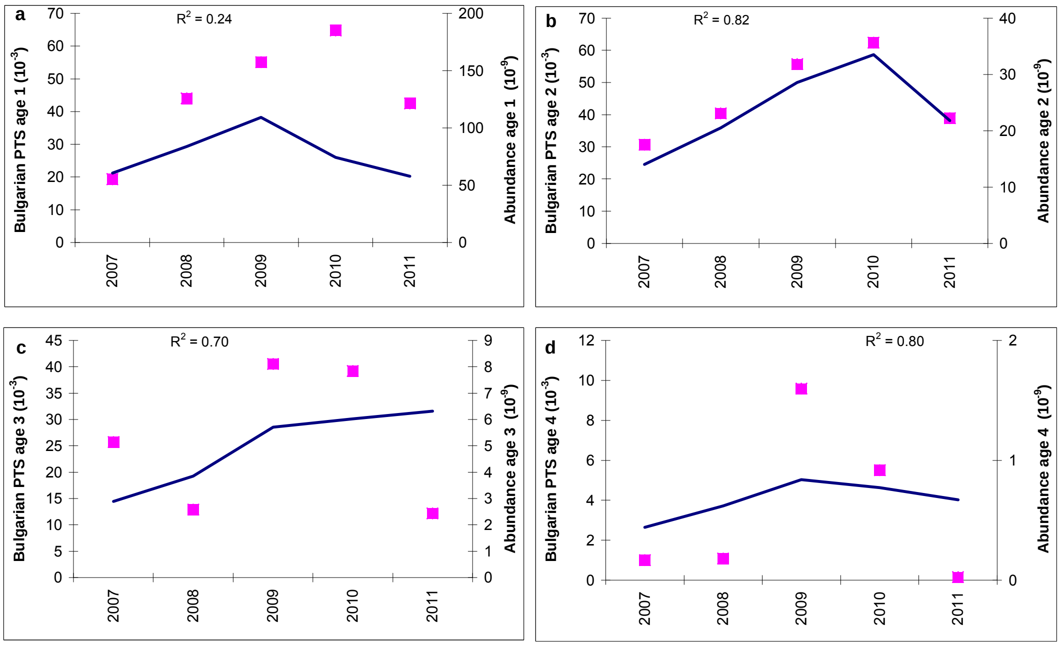


Figure 6.1.4.1.3.5. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Bulgarian PTS (best fit is given by linear relationships and r^2 are displayed): (a) Age 1. (b) Age 2. (c) Age 3. (d) Age 4.

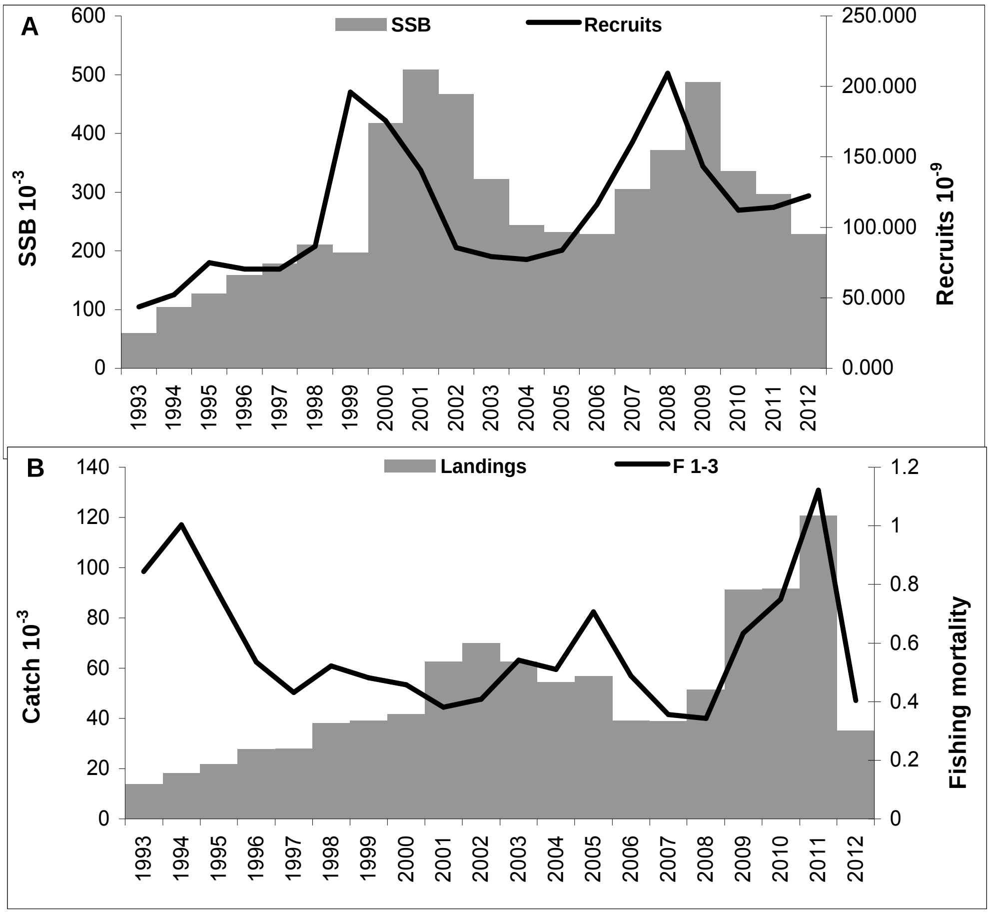


Fig. 6.1.4.1.3.6. Time-series of sprat population estimates: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4. line).

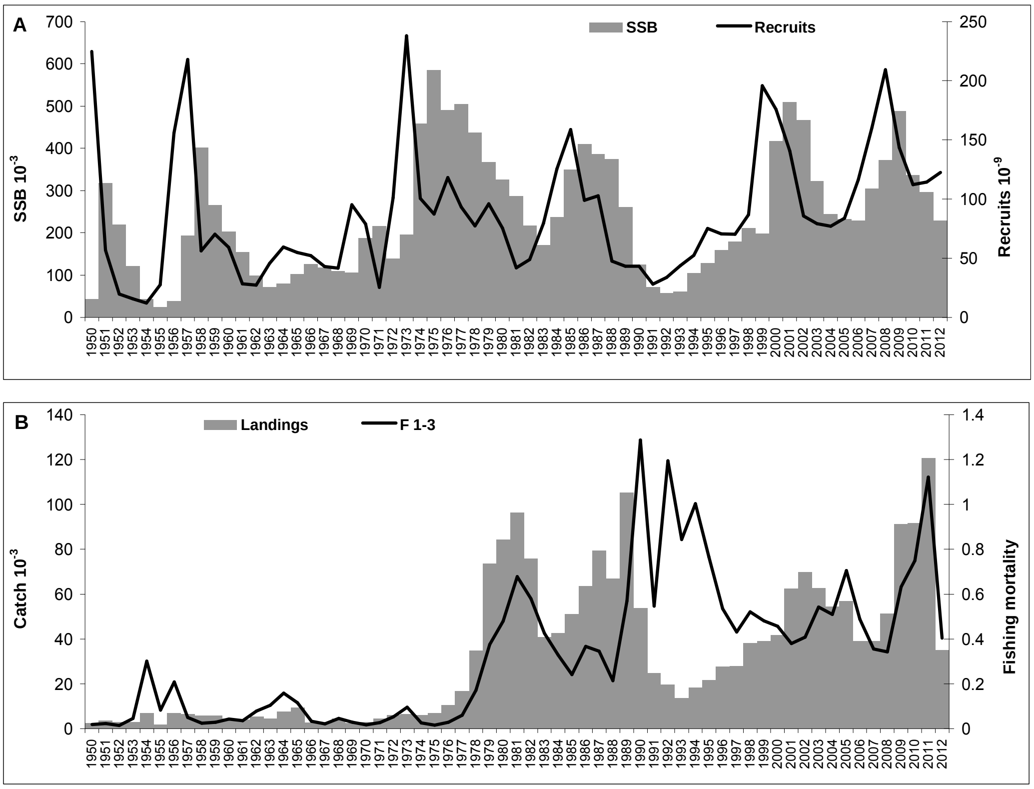


Fig. 6.1.4.1.3.7. Time-series of sprat population estimates – present results combined with historical estimates from Daskalov 1998: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4. line).

Table 6.1.4.1.3.1. Sprat in the Black Sea 1990-2009: ICA results and diagnostics.

Fishing Mortality (per year)

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.0079	0.0030	0.0004	0.0021	0.0054	0.0037	0.0070	0.0031	0.0078	0.0066	0.0153	0.0144	0.0200	0.0138	0.0101
1	0.2670	0.1495	0.1006	0.1021	0.1206	0.0998	0.1385	0.0761	0.1876	0.1534	0.1989	0.1870	0.2591	0.1792	0.1306
2	0.7745	0.9511	0.7676	0.5586	0.3348	0.4077	0.4431	0.3971	0.3192	0.4873	0.5209	0.4898	0.6786	0.4694	0.3420
3	1.4909	1.9093	1.4307	0.9450	0.8371	1.0572	0.8646	0.8994	0.6355	0.5852	0.9062	0.8522	1.1806	0.8166	0.5950
4	0.7769	0.8134	0.6178	0.4564	0.3773	0.4256	0.4343	0.3711	0.3920	0.4085	0.5209	0.4898	0.6786	0.4694	0.3420
5	0.7769	0.8134	0.6178	0.4564	0.3773	0.4256	0.4343	0.3711	0.3920	0.4085	0.5209	0.4898	0.6786	0.4694	0.3420

Fishing Mortality (per year)

AGE	2008	2009	2010	2011	2012
0	0.0097	0.0179	0.0212	0.0317	0.0114
1	0.1258	0.2322	0.2747	0.4114	0.1484
2	0.3294	0.6083	0.7195	1.0777	0.3887
3	0.5731	1.0582	1.2518	1.8748	0.6763
4	0.3294	0.6083	0.7195	1.0777	0.3887
5	0.3294	0.6083	0.7195	1.0777	0.3887

Population Abundance (1 January)

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	43.69	52.30	74.96	70.36	70.31	86.56	195.85	175.74	140.45	85.60	79.19	77.10	83.78	116.30	160.56
1	17.31	22.86	27.49	39.51	37.02	36.87	45.48	102.55	92.38	73.48	44.84	41.12	40.07	43.31	60.48
2	3.94	5.13	7.61	9.62	13.80	12.69	12.91	15.31	36.76	29.61	24.38	14.21	13.19	11.96	14.00
3	0.39	0.70	0.77	1.37	2.13	3.82	3.26	3.20	3.98	10.33	7.03	5.60	3.37	2.59	2.89
4	0.04	0.03	0.04	0.07	0.21	0.36	0.51	0.53	0.50	0.82	2.23	1.10	0.92	0.40	0.44
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

x 10 ^ 9

Population Abundance (1 January)

AGE	2008	2009	2010	2011	2012	2013
0	209.27	143.35	112.16	114.29	459.82	168.76
1	83.81	109.29	74.25	57.90	58.38	239.71
2	20.53	28.58	33.51	21.82	14.84	19.46
3	3.85	5.71	6.02	6.31	2.87	3.89
4	0.62	0.84	0.77	0.67	0.37	0.56
5	0.00	0.00	0.02	0.03	0.00	0.10

x 10 ^ 9

Weighting factors for the catches in number

AGE	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted Age-Structured Index Values

Bul Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	23.95	29.52	42.39	39.35	39.61	47.91	111.46	94.95	76.84	45.83	42.28	39.75	44.70	63.97	88.86
2	12.33	20.06	28.13	45.14	40.04	40.01	48.57	121.21	89.78	72.68	43.04	36.35	36.59	45.65	67.35
3	1.58	2.19	4.97	8.17	13.14	12.37	11.94	16.92	45.02	26.11	21.35	10.90	10.05	12.55	16.86
4	0.08	0.11	0.21	0.63	1.06	1.53	1.63	1.53	2.46	6.34	3.18	2.43	1.17	1.38	1.93

x 10 ^ 3

Bul Predicted

AGE	2009	2010	2011	2012
1	109.86	73.07	53.22	61.20
2	81.58	90.45	49.24	47.27
3	19.64	18.79	14.43	11.96
4	2.29	1.98	1.43	1.14

x 10 ^ 3

Ukr Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	63.47	78.23	112.33	104.29	104.96	126.96	295.39	251.64	203.63	121.46	112.06	105.34	118.47	169.53	235.49
2	20.46	33.30	46.69	74.93	66.46	66.40	80.61	201.18	149.02	120.63	71.44	60.33	60.73	75.76	111.79
3	3.17	4.39	9.99	16.42	26.39	24.85	23.98	33.99	90.43	52.45	42.89	21.89	20.18	25.20	33.87
4	0.09	0.11	0.22	0.66	1.12	1.61	1.72	1.61	2.59	6.68	3.35	2.56	1.23	1.45	2.04

x 10 ^ 3

Ukr Predicted

AGE	2009	2010	2011	2012
1	291.14	193.65	141.04	162.19
2	135.40	150.13	81.73	78.46
3	39.46	37.74	28.99	24.02
4	2.41	2.08	1.51	1.20

x 10 ^ 3

Bul survey Predicted

AGE	2007	2008	2009	2010	2011
1	35583.	49429.	61109.	40645.	29604.
2	31237.	46090.	55824.	61899.	33697.
3	17767.	23882.	27822.	26609.	20438.
4	1197.	1680.	1986.	1717.	1246.

Fitted Selection Pattern

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.0102	0.0031	0.0005	0.0037	0.0161	0.0091	0.0158	0.0079	0.0245	0.0135	0.0294	0.0294	0.0294	0.0294	0.0294
1	0.3447	0.1571	0.1310	0.1828	0.3603	0.2448	0.3126	0.1916	0.5878	0.3149	0.3818	0.3818	0.3818	0.3818	0.3818
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.9250	2.0074	1.8639	1.6918	2.5005	2.5932	1.9513	2.2651	1.9906	1.2009	1.7397	1.7397	1.7397	1.7397	1.7397
4	1.0031	0.8551	0.8049	0.8171	1.1270	1.0439	0.9801	0.9346	1.2280	0.8383	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0031	0.8551	0.8049	0.8171	1.1270	1.0439	0.9801	0.9346	1.2280	0.8383	1.0000	1.0000	1.0000	1.0000	1.0000

Fitted Selection Pattern

AGE	2008	2009	2010	2011	2012
0	0.0294	0.0294	0.0294	0.0294	0.0294
1	0.3818	0.3818	0.3818	0.3818	0.3818
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.7397	1.7397	1.7397	1.7397	1.7397
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 1- 3	SoP (%)
1992	33782600	114191	56761	19700	0.3471	0.844	100
1993	45188990	138763	61942	13800	0.2228	1.003	100
1994	55266250	163657	108391	18219	0.1681	0.766	99
1995	77426390	211675	134249	21746	0.1620	0.535	100
1996	74050610	239734	165684	27778	0.1677	0.431	99
1997	71506480	259063	187557	27963	0.1491	0.521	100
1998	86695340	305338	218643	38117	0.1743	0.482	99
1999	186274610	387156	200881	39152	0.1949	0.457	98
2000	181222870	583779	402556	41769	0.1038	0.381	100
2001	141529580	652465	510936	62587	0.1225	0.409	100

```
   2002     85901260    555269    469368     69894   0.1489   0.542    99
   2003     84895790    409000    324104     62716   0.1935   0.510    99
   2004     73765070    331602    257837     54574   0.2117   0.706   100
   2005     85273460    311430    226156     56854   0.2514   0.488   100
   2006    123693570    353236    229543     39048   0.1701   0.356   100
   2007    197275040    515066    317791     39008   0.1227   0.343    99
   2008    170296280    605016    434720     51463   0.1184   0.633    99
   2009    135560140    588717    453157     91376   0.2016   0.749   100
   2010    119694830    436044    316350     91594   0.2895   1.121    99
   2011    104761280    416607    311846    120710   0.3871   0.404   100

 -----------------------------------------------------------------
 No of years for separable analysis : 10
 Age range in the analysis : 0  . . . 5
 Year range in the analysis : 1993  . . . 2012
 Number of indices of SSB : 0
 Number of age-structured indices : 3

 Parameters to estimate : 39
 Number of observations : 222

 Conventional single selection vector model to be fitted.



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 PARAMETER ESTIMATES

 iParm.i      i Maximum i    i        i         i         i         i Mean of i
 i No. i      i Likelh. i CV i  Lower i Upper   i  -s.e.  i   +s.e. i Param.  i
iii Estimatei (%)i 95% CL i 95% CL  iii Distrib.i
Separable model : F by year
    1  2003     0.5209  21    0.3436    0.7897    0.4213    0.6441    0.5328
    2  2004     0.4898  20    0.3268    0.7342    0.3984    0.6022    0.5004
    3  2005     0.6786  19    0.4635    0.9936    0.5587    0.8243    0.6916
    4  2006     0.4694  21    0.3104    0.7099    0.3801    0.5797    0.4800
    5  2007     0.3420  22    0.2219    0.5270    0.2743    0.4264    0.3504
    6  2008     0.3294  21    0.2152    0.5043    0.2651    0.4093    0.3373
    7  2009     0.6083  19    0.4168    0.8878    0.5016    0.7377    0.6197
    8  2010     0.7195  18    0.5021    1.0310    0.5989    0.8645    0.7317
    9  2011     1.0777  18    0.7571    1.5339    0.9000    1.2904    1.0953
   10  2012     0.3887  32    0.2076    0.7279    0.2823    0.5353    0.4092

 Separable Model: Selection (S) by age
   11      0    0.0294  23    0.0186    0.0465    0.0233    0.0372    0.0302
   12      1    0.3818  17    0.2710    0.5378    0.3205    0.4547    0.3877
           2    1.0000     Fixed : Reference Age
   13      3    1.7397  13    1.3394    2.2597    1.5224    1.9881    1.7553
           4    1.0000     Fixed : Last true age

 Separable model: Populations in year 2012
14      0  .4598E+09  68  .1191E+09 .1775E+10 .2309E+09 .9159E+09 .5830E+09
   15      1   58383008  34   29675187 114862815  41337201  82457823  61968601
   16      2   14840812  25    9074257  24271926  11546605  19074845  15315705
   17      3    2872167  24    1778187   4639185   2248893   3668179   2959405
   18      4     374334  31     203665    688023    274404    510656    392827

Separable model: Populations at age
19   2003    2225155  34    1128645   4386951   1573804   3146080   2362685
   20  2004    1099293  27     644462   1875123    837122   1443571   1140860
   21  2005     923622  25     565078   1509664    718826   1186765    953104
   22  2006     400015  25     242621    659514    309946    516257    413245
   23  2007     442335  23     276532    707550    348070    562129    455223
   24  2008     617104  22     398733    955071    493838    771139    632617
   25  2009     838620  21     552364   1273224    677711   1037732    857867
   26  2010     766538  23     487282   1205832    608344    965868    787291
   27  2011     665514  24     415015   1067210    523019    846830    685114



 Age-structured index catchabilities
                                       Bul

 Linear model fitted. Slopes at age :
28   1  Q  .1815E-02  18 .1516E-02 .3167E-02 .1815E-02 .2644E-02 .2230E-02
   29   2  Q  .6220E-02  18 .5193E-02 .1085E-01 .6220E-02 .9061E-02 .7642E-02
   30   3  Q  .9389E-02  19 .7811E-02 .1656E-01 .9389E-02 .1378E-01 .1158E-01
   31   4  Q  .5941E-02  20 .4900E-02 .1076E-01 .5941E-02 .8873E-02 .7408E-02


Ukr

Linear model fitted. Slopes at age :
32   1  Q  .4811E-02  18 .4017E-02 .8393E-02 .4811E-02 .7007E-02 .5910E-02
   33   2  Q  .1032E-01  18 .8619E-02 .1802E-01 .1032E-01 .1504E-01 .1268E-01
   34   3  Q  .1886E-01  19 .1569E-01 .3326E-01 .1886E-01 .2767E-01 .2327E-01
   35   4  Q  .6262E-02  20 .5165E-02 .1134E-01 .6262E-02 .9353E-02 .7808E-02


Bul survey

 Linear model fitted. Slopes at age :
   36   1  Q  .1010E-02  36 .7087E-03 .3010E-02 .1010E-02 .2112E-02 .1563E-02
   37   2  Q  .4257E-02  36 .2987E-02 .1269E-01 .4257E-02 .8906E-02 .6591E-02
   38   3  Q  .1330E-01  37 .9260E-02 .4058E-01 .1330E-01 .2826E-01 .2081E-01
   39   4  Q  .5162E-02  39 .3525E-02 .1673E-01 .5162E-02 .1142E-01 .8309E-02
```

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.3010	-0.6054	-0.8399	-0.0176	0.9856	-0.1374	-0.1868	0.5250	-0.0214	0.0000
1	0.0644	0.4036	-0.0001	0.2508	0.1028	0.1856	-0.1935	-0.3927	-0.2555	-0.1628
2	-0.1981	-0.0302	0.0515	-0.1033	-0.3598	-0.1608	-0.1174	-0.4985	0.2303	-0.0984
3	0.0425	0.1872	-0.0261	-0.2333	-0.0894	0.1591	0.2297	0.3640	0.7374	0.1420
4	0.1043	-0.0245	0.1842	-0.0915	0.2868	0.3839	0.3564	0.1650	0.2047	0.1892

AGE-STRUCTURED INDEX RESIDUALS

Bul

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	-0.895	-0.410	-0.032	0.304	0.279	0.746	-0.042	0.082	-0.032	0.216	0.438	0.057	-0.096	-0.111	-0.114
2	1.540	0.888	0.305	-0.465	0.379	-0.268	0.452	-0.533	-0.233	-0.378	0.030	-0.270	-0.525	-0.325	0.065
3	2.334	1.214	0.641	-0.275	-0.912	-1.002	-0.541	-1.434	-0.668	-0.598	-0.292	-0.152	-0.870	-0.210	1.124
4	1.077	0.763	1.034	-0.035	-0.676	-1.636	-0.889	-1.891	-0.675	-0.904	0.213	-0.952	0.110	0.229	0.981

Bul

Age	2009	2010	2011	2012
1	-0.508	-0.142	-0.277	0.543
2	-0.343	-0.268	-0.112	0.066
3	0.003	1.040	0.802	-0.196
4	0.323	1.124	1.202	0.614

Ukr

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.673	0.034	-0.011	-0.585	-0.565	-0.265	-0.283	-0.264	-0.252	-0.466	0.113	0.075	0.420	-0.288	0.190
2	1.298	1.136	0.929	-0.397	0.025	0.252	0.596	-0.531	0.185	-0.462	-0.432	0.379	0.130	-1.142	-0.700
3	0.932	0.764	-0.058	-0.445	0.567	0.411	1.019	-0.411	-0.166	-0.099	0.244	0.314	0.201	-0.400	0.102
4	1.753	0.175	1.102	0.086	0.743	-1.062	1.266	0.289	0.585	0.487	0.412	1.146	0.714	-2.675	0.409

Ukr

Age	2009	2010	2011	2012
1	0.141	0.598	0.587	0.151
2	0.057	-0.802	-0.144	-0.373
3	-0.052	-2.054	-0.701	-0.159
4	-1.293	-2.153	-2.648	0.673

Bul survey

Age	2007	2008	2009	2010	2011
1	-0.609	-0.116	-0.104	0.467	0.362
2	-0.018	-0.132	-0.002	0.008	0.144
3	0.370	-0.614	0.377	0.387	-0.520
4	-0.181	-0.441	1.574	1.165	-2.117

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 2003 to 2012
Variance 0.1615
Skewness test stat. 1.5630

Kurtosis test statistic	0.5471
Partial chi-square	0.2591
Significance in fit	0.0000
Degrees of freedom	23

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Bul

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0366	0.0699	0.2268	0.2327
Skewness test stat.	-0.4087	2.6976	1.3772	-0.7781
Kurtosis test statisti	0.2440	1.7192	0.0000	-0.8572
Partial chi-square	0.0620	0.1259	0.4775	0.6134
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	19	19	19	19
Degrees of freedom	18	18	18	18
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR Ukr

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0372	0.1096	0.1180	0.4356
Skewness test stat.	0.4054	0.6829	-2.0760	-1.7324
Kurtosis test statisti	-0.8304	-0.5093	2.1231	-0.2258
Partial chi-square	0.0571	0.1818	0.2141	1.1388
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	19	19	19	19
Degrees of freedom	18	18	18	18
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR Bul survey

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0465	0.0024	0.0673	0.5341
Skewness test stat.	-0.2534	0.1810	-0.3836	-0.3354
Kurtosis test statisti	-0.5341	-0.2442	-0.8244	-0.4905
Partial chi-square	0.0177	0.0009	0.0268	0.2921
Significance in fit	0.0000	0.0000	0.0001	0.0097
Number of observations	5	5	5	5
Degrees of freedom	4	4	4	4
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	106.5321	222	39	183	0.5821
Catches at age	4.9460	50	27	23	0.2150
Aged Indices					
Bul	40.7530	76	4	72	0.5660
Ukr	50.4295	76	4	72	0.7004
Bul survey	10.4036	20	4	16	0.6502

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	10.0631	222	39	183	0.0550
Catches at age	3.7140	50	27	23	0.1615
Aged Indices					
Bul	2.5471	76	4	72	0.0354
Ukr	3.1518	76	4	72	0.0438
Bul survey	0.6502	20	4	16	0.0406

6.1.5 *Short term prediction of stock biomass and catch*

6.1.5.1 Justification

A deterministic short term prediction of stock size and catch was conducted based on ICA results.

6.1.5.2 Input parameters

The input parameters are listed in the Table 6.1.5.2.1 below. They do represent short term averages of the ICA inputs. The exploitation pattern used is the 2012 estimated vector rescaled to the average exploitation patterns estimated for the years 2009-2011. Due to the lack of recruitment index. recruitment was estimated using the geometric mean from 2009-2011.

As the fishery for sprat in the Black Sea is not constrained by an international TAC. the year 2012 was defined as a status quo effort year with unchanged fishing mortality.

Table 6.1.5.2.1. Sprat in the Black Sea. Input to short term prediction.

2013						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	122484550	0.6400	0.0000	0.001	0.0114	0.0016
1	63850877	0.9500	1.0000	0.0026	0.1484	0.0022
2	19464119	0.9500	1.0000	0.0039	0.3887	0.0042
3	3890757	0.9500	1.0000	0.0055	0.6763	0.0055
4	564415	0.9500	1.0000	0.0079	0.3887	0.0061
5	132261	0.9500	1.0000	0.01	0.3887	0.01
2014						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	122484550	0.6400	0.0000	0.001	0.0114	0.0016
1		0.9500	1.0000	0.0026	0.1484	0.0022
2		0.9500	1.0000	0.0039	0.3887	0.0042
3		0.9500	1.0000	0.0055	0.6763	0.0055
4		0.9500	1.0000	0.0079	0.3887	0.0061
5		0.9500	1.0000	0.01	0.3887	0.01
2015						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	122484550	0.6400	0.0000	0.001	0.0114	0.0016
1		0.9500	1.0000	0.0026	0.1484	0.0022
2		0.9500	1.0000	0.0039	0.3887	0.0042
3		0.9500	1.0000	0.0055	0.6763	0.0055
4		0.9500	1.0000	0.0079	0.3887	0.0061
5		0.9500	1.0000	0.01	0.3887	0.01

6.1.5.3 Results

Table 6.1.5.3.1. Sprat in the Black Sea. Single option (status quo) short term prediction.

2013	F-factor:	1	reference F1-3	0.4045		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0114	1029193	1647	122484549.8	122485	0	0
1	0.1484	5750488	12651	63850876.54	166012	63850877	166012
2	0.3887	4169982	17514	19464118.51	75910	19464119	75910
3	0.6763	1299760	7149	3890756.519	21399	3890757	21399
4	0.3887	120920	738	564415.4541	4459	564415	4459
5	0.3887	20783	208	97006.73263	970	97007	970
		12391126	39907	210351724	391235	87867175	268750

2014	F-factor:	1	reference F1-3	0.4045		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0114	1029193	1647	122484550	122485	0	0
1	0.1484	5750488	12651	63850877	166012	63850877	166012
2	0.3887	4560757	19155	21288130	83024	21288130	83024
3	0.6763	1704763	9376	5103110	28067	5103110	28067
4	0.3887	163927	1000	765158	6045	765158	6045
5	0.3887	31703	317	147979	1480	147979	1480
		13240831	44146	213639804	407113	91155254	284628
2015	F-factor:	1	reference F1-3	0.4045		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0114	1029193	1647	122484550	122485	0	0
1	0.1484	5750488	12651	63850877	166012	63850877	166012
2	0.3887	4560757	19155	21288130	83024	21288130	83024
3	0.6763	1864519	10255	5581330	30697	5581330	30697
4	0.3887	215006	1312	1003580	7928	1003580	7928
5	0.3887	42978	430	200609	2006	200609	2006
		13462941	45450	214409076	412152	91924526	289667

The *status quo* fishing in 2013 would result in landings 39 907. and SSB of 268 750 t. Thus the forecasted 2013 SSB is expected to increase by about 18 % compared to 2012 (SSB=228 314 t) and total catch to increase by about 14% from the catch recorded in 2012 - 35 050 t. In 2013 and 2014 the status quo model predicts a slight increase in biomass and catches relative to 2013 (Table 6.1.5.3.1.).

Recruitment estimates are rather imprecise due to the lack of survey data. Recruitment have increased up to 2008, afterward the trend reversed. In short-term forecast we used a geometric mean over 2009-2012 equal of 122 484 549 800.

Catches have been very high during 2009-2011 due to quickly expending Turkish fishery. In 2012 total catch suddenly dropped to 35 050 t. The largest drop in the catches was due to the low catch by the Turkish fishery. Under the status quo F assumption. catches are expected to increase in 2013, and slightly decrease in 2014 - 2015.

Given that the state of the stock depends greatly on a variable recruitment, the dynamic nature of developing Turkish sprat fishery and the lack of quota constraints on the sprat fisheries, the status quo assumption must be taken with a caution when considered in management advice.

More management options through multiplications of the fishing mortality are given in Table 6.1.5.3.2. The Fmsy level of fishing mortality of 0.64 (corresponding to exploitation rate of 0.4. Patterson 1992. Daskalov et al. 2011) would reduce forecast catches from 64 544 t in 2014 to 56 596 in 2015. On the other hand, according to the *status quo* prediction the catch increases from 39 907 t in 2013 to 45 450 t in 2015. Thus, given the present state of spawning stock, recruitment and exploitation rate fishing at Fmsy does not seem a sustainable option.

At present the sprat stock is experiencing a downward trend from historically high abundance peaking in 2008-2009. Such a trend combined with the unprecedentedly high fishing pressure during the last years can seriously degrade the state of the stock leading to low SSB and catches in the next years. The record catches over 2009-2011 seemed of being sustained by some of the highest historically recorded levels of recruitment (over 2007-2009), but reversed trend in recruitment over 2010-2012 and indications of entering in unfavourable environmental regime should warn against further expansion of the sprat fisheries over the next years.

Table 6.1.5.3.2. Sprat in the Black Sea. Management option table (status quo in 2011) providing short term prediction.

2013					2014					2015		
F-factor	reference F	stock biomass	sp. stock biomass	catch in weight	F-factor	reference F	stock biomass	sp. stock bioma	catch in weight	stock biomass	sp. stock bioma	catch
1.0000	0.4045	391235	268750	39907	0.0000	0.0000	407367	284882	0	451213	328728	0
					0.1000	0.0404	407367	284882	5052	446723	324238	6235
					0.2000	0.0809	407367	284882	9947	442390	319905	12005
					0.3000	0.1213	407367	284882	14690	438208	315723	17349
					0.4000	0.1602	407367	284882	19287	434173	311688	22301
					0.5500	0.2203	407367	284882	25926	428374	305889	29070
					0.6000	0.2403	407367	284882	28070	426506	304021	31163
					0.7000	0.2831	407367	284882	32268	422865	300380	35128
					0.8000	0.3236	407367	284882	36344	419343	296858	38817
					0.9000	0.3640	407367	284882	40302	415936	293451	42249
				Fsq	**1.0000**	**0.4045**	**407367**	**284882**	**44146**	**412638**	**290153**	**45450**
					1.1000	0.4449	407367	284882	47883	409447	286962	48434
					1.2000	0.4854	407367	284882	51516	406353	283868	51222
					1.3000	0.5258	407367	284882	55050	403356	280871	53825
					1.4000	0.5663	407367	284882	58489	400452	277967	56263
					1.5000	0.6067	407367	284882	61835	397635	275150	58546
				Fmsy	**1.583**	**0.640**	**407367**	**284882**	**64544**	**395360**	**272875**	**56596**

6.1.6 *Medium term prediction of stock biomass and catch*

The EWG did not undertake medium term projections.

6.1.7 *Long term predictions*

Fmax could not be estimated due to shape to the YpR curve. which has a maximum well outside of the reasonable range. The skewed shape of the YpR curve results from the high natural mortality and the short life span of sprat in the Black Sea. Due to such effects.STECF EWG 11-16 on Black Sea does not consider $F_{0.1}$ as an appropriate management reference point. and proposes a limit reference point of exploitation rate E≤0.4 which implies Fmsy = 0.64. In 2012 average F is 0.404,corresponding to an exploitation rate of about E=0.298 (natural mortality M=0.95), is bellow Fmsy.

6.1.8 *Scientific advice*

6.1.8.1 Short term considerations

The EWG accepted the current ICA assessment as adequately presenting the state and dynamics of the stock and the development of the fisheries.

State of the spawning stock size: According to the present assessment in recent years the SSB ranges at medium to high levels(between 200 000 and 500 000 t). In 2012, SSB has dropped to 228 000 t. Under a constant recruitment scenario and status quo F = 0.404, in2013 SSB is expected to increase to 268 750 and after to slightly increase up to 289 667 t by 2015.

State of recruitment: Recruitment has increased up to 2008 and since then started a decreasing trend. Recruitment estimates are rather imprecise due to the lack of survey data. In short-term forecast we used a geometric mean over 2009-2012 average value of 122484549 800.

State of exploitation: Over the last few years the fishing mortality has peaked in 2010-2011 at a level of 0.7 - 1.12. Proposing a limit reference point of exploitation rate E≤0.4 that equals F = 0.64 (as suggested by Patterson 1992 for short living fish), the EWG considers the stock of sprat being exploited unsustainably over the last years. The current F=0.404equals an exploitation rate of about E=0.298 (natural mortality M=0.95) has resulted from a more than 3 times drop in total catches in 2012 compared to 2011.*Status quo* fishing implies catches in the range of 39 907- 45 504 t over 2013 - 2015 which are bellow the recommended catch of 64 544 t,at

Fmsy.However, given the downward trend in recruitment and indications of unfavourable environmental regime the EWG suggests the catches in the next years do not exceed the s*tatus quo* level.

6.1.8.2 Medium term considerations

Due to the cyclic nature of recruitment and unknown dependence on environmental conditions the WG is not able to provide medium term forecast. The record catches over 2009-2011 seemed of being sustained by some of the highest historically recorded levels of recruitment (over 2007-2009), but reversed trend in recruitment over 2010-2012 and indications of entering in unfavourable environmental regime should warn against further expansion of the sprat fisheries over the next years.

6.2 Turbot in the Black Sea

6.2.1 Biological features

6.2.1.1 Stock Identification

Turbot (*Psetta maxima/Scophthalmus maximus*) is a demersal species and occurs in local shoals all over the shelf area of all Black Sea countries at depths up to 100m -140m . Species inhabitsdifferent habitats, but mostly on sandy and silty bottoms and mussel beds. The reproduction occurs during the spring season – between April and June. Turbot in the Black Sea is represented by several local populations, which migrate and mix in the adjacent zones. Local populations are independent units of the stock, and have to be covered in order to ensure an accurate assessment of the stock at regional level. The gaps in available information regarding distribution of different stock unit, accurate fisheries statistics, estimates of discards and by-catch, availability of biological data and share of IUU fisheries continue to exist. The present assessment is based on the analysis of the best available information, obtained from combined data of all Black Sea countries and assuming the stock as representing a single unit in the entire Black Sea.

6.2.1.2 Growth

Turbot is a long living species with a slow growth rate. The parameters reported here by countries are considered appropriate for the description of an average growth performance of the species in GSA 29 – Tab. 6.2.1.2.1.

Table 6.2.1.2.1. Growth parameters of turbot by countries and periods.

COUNTRY	AREA	YEAR_PERIOD	SPECIES	SEX	L_INF	K	t_0	*a*	*b*
ROM	***29***	***2003-2005***	***TUR***	***C***	***80.98***	***0.15***	***-1.37***	***0.000018***	***3.01***
ROM	***29***	***2006-2008***	***TUR***	***C***	***72.5***	***0.212***	***-1.15***	***0.00806***	***3.22***
ROM	***29***	***2009-2011***	***TUR***	***C***	***86.3***	***0.19***	***-2.1***	***0.030088***	***2.87***
BGR	***29***	***2007-2008***	***TUR***	***C***	***77.81***	***0.242***	***0.152***	***0.000431***	***2.21***
BGR	***29***	***2008-2009***	***TUR***	***C***	***120.4***	***0.076***	***-2.811***	***0.000011***	***3.13***
BGR	29	2008-2009	TUR	F	129.81	0.065	-3.351	0.000013	3.11
BGR	29	2008-2009	TUR	M	67.38	0.246	-1.217	0.000041	2.78
BGR	29	2007-2008	TUR	M	57.6	0.507	0.458	0.000918	1.96
BGR	29	2007-2008	TUR	F	80.31	0.213	-0.136	0.000424	2.22
BGR	29	2006-2007	TUR	M	77.49	0.158	-1.975	0.000022	2.92
BGR	29	2006-2007	TUR	F	124.27	0.08	-2.136	0.000021	2.94
BGR	***29***	***2006-2007***	***TUR***	***C***	***79.26***	***0.173***	***-1.561***	***0.000008***	***3.17***
UKR (NE)	29	2000 - 2006	TUR	C				0.000216	2.48
UKR (NW)	***29***	***2008 - 2009***	***TUR***	***C***	***74***	***0.106***	***-1.73***	***0.001437***	***1.94***
TR	**29**	**1990 - 1991**	**TUR**	**C**	**82.57**	**0.17**	**-0.93**	**0.0085**	**3.18**
TR	**29**	**1990 - 1996**	**TUR**	**C**	**96.24**	**0.119**	**-0.01**	**0.0112**	**3.12**
TR	**29**	**1998 - 2000**	**TUR**	**C**	**95.9**	**0.104**	**-1.55**	**0.0106**	**3.14**
BGR-RO	29	2010	TUR	M	73.36	0.194	-1.779	0.00004	2.799
BGR-RO	29	2010	TUR	F	113.553	0.089	-2.489	0.0000007	3.795
TR	29	2010	TUR	C	60.57	0.218	0.25	0.12	3.081
BGR	29	2011	TUR	C	69.98	0.395	1.043	0.000033887	2.837
TR(west)	29	2011	TUR	C	96.376	0.112	-1.304	0.014	3.059
TR(east)	29	2011	TUR	C	101.12	0.11	-1.24	0.01	3.17
RO	29	2011	TUR	C	86.32	0.242	-1.971	0.06254606	2.66
BGR	29	2012	TUR	C	88.44	0.17	-0.34	0.0000338	2.86
RO	29	2012	TUR	C	86.32	0.2179	-0.486	0.03502439	2.842
TR	29	2012	TUR	C	82.41	0.342	-3.73	0.012	3.09

The Turkish data (in bold) were used to estimate growth parameters for the historical part of the time series (1950-1999) while Romanian, Bulgarian, Ukranian and Turkish data (in bold italics) from 2003 to 2012 were used to estimate growth parameters for the modern part of the times series (2000-2012). Therefore, the average *k*, L_{inf}, t_0, *a* and *b* were estimed for sex combined.

6.2.1.3 Maturity

The species reaches sexual maturity at ages between 3 and 5. The maturity ogive for 2012 was prepared based on data, collected during different surveys (DCF, from commercial fisheries, national monitoring programs, etc.)from Bulgaria, Romania, Ukraine and Turkey, averaged by age groups.The proportions of mature individuals by age groups for the period 1970 – 2012 are given in Table 6.2.1.3.1.Maturity ogives were calculated as the average for the period 2007 – 2009 due to good data consistency for these years and applied over the whole time series.

Table 6.2.1.3.1. Common maturity ogive of turbot by ages and years.

Year/Age	1	2	3	4	5	6	7	8	9	10+
1970-2006	0	0	0.75	1	1	1	1	1	1	1
2007	0	0	0.38	0.61	1	1	1	1	1	1
2008	0	0	0.51	0.76	1	1	1	1	1	1
2009	0	0	0.41	0.67	1	1	1	1	1	1
2010	0	0	0.22	0.83	1	1	1	1	1	1
2011	0	0.06	0.20	0.86	1	1	1	1	1	1
2012	0	0.13	0.52	0.92	1	1	1	1	1	1

6.2.2 *Fisheries*

6.2.2.1 General description

The Black Sea turbot (*Psetta maxima/Scophthalmus maximus*) historically has been fished by all coastal states, using both stationary and mobile fishing gears (gillnets and bottom trawls). The species is often caught as a by-catch of otter trawls, long lines and purse seiners fishery. Total annual landings in the Black Sea present a decreasing trend during the last years - from 1035 t in 2007 to 486 t in 2011, but in 2012 slight increase was observed – 528 t. IUU fisherieson turbot also occur.

6.2.2.2 Management regulations applicable in 2012 and 2013

Turbot fisheries in Black Sea EU waters are being managed through the annual establishment of fishing opportunities (EU quotas) since 2008, by the adoption of Council Regulations[1]. During the last three years, the EU turbot quota has been fixed at 86.4 t and allocated to Bulgaria and Romania (50 % each). The same Council Regulations set up every year the prohibition of fishing activities during reproduction period for turbot has been in force from 15 April to 15 June in European Community waters of the Black Sea. It has to be noticed that the same period of prohibition is fixed by Turkish National Legislation.

During the 37 Session of the General Fisheries Commission for the Mediterranean (GFCM), a recommendation to establish a set of minimum standards for Turbot fisheries in the Black Sea was adopted. This recommendation, set up minimum conservation size (45 cm) for turbot and minimum mesh size (400 mm) for gillnets. It has to be noticed that these measures were already in place in Turkey and the EU.

[1]CR (EU) No 1261 fixes relevant fishing opportunities for 2013

In Turkey, turbot fisheries have been traditionally conducted by bottom set gill nets with minimum mesh size of 320-400 mm (Tonay, Öztürk, 2003) and by bottom trawls - with minimum mesh size 40 mm. However the above mentioned GFCM recommendation establishes gillnets as the only gear allowed to fish turbot in the Black Sea.

Though some violations, turbot fishery is conducted along offshore waters starting from 3 miles from coast to 9.7 miles. Fishing depth ranges between 25 m and 100 m. The catches are highest within depths of 50-60 m. The basic management criteria for turbot fisheries in 2012-2014 announced by Commercial Fishery Advice of General Directorate of Fishery in Turkey are summarized below (Anonim, 2012):

- Area closures: Bottom trawling is prohibited in the areas between 1) Sinop city, İnceburun (42° 05.959' N-34° 56.695'E and Samsun city Çayağzı cape (41° 41.040' N-35° 25.193' E), 2) Ordu city; Ünye, Taşkana cape (41° 08.725' N-37° 17.531' 4) and Georgia border. Furthermore, it is also banned within 2 miles from land between Zonguldak city; Ereğli, Baba cape (41° 17.342' N-31° 23.937'E) and Bartın city; Amasra, Tekke cape (41° 43.485' N-32° 19.258' E) (Fig.6.2.2.2.1). In the rest of the areas, the waters open for trawling are 3 miles from the coast.

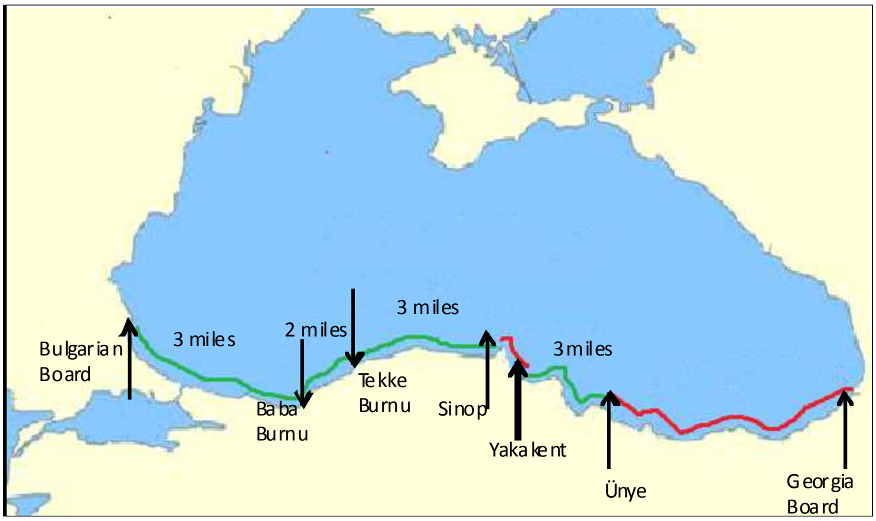


Figure 6.2.2.2.1. Area closures and distance limitations for bottom trawling along theTurkish coast (Green lines: open areas, red lines: area closures).

- Time closures: In open areas, bottom trawling for turbot is banned between 15 April and 15 September. Turbot fishery by gillnet is allowed except during the period 15 April – 15 June.
- Mesh size limitations: a) Mesh size of the codend should not be lower than 40 mm for bottom trawl nets. b) Mesh size of gillnets should not be lower than 400 mm. c) Long lines and trammel gillnets are forbidden for turbot fishery.
- Minimum legal catch size: Minimum legal size (total length) is determined as 45 cm for all fishing gears.

In Ukraine turbot fisheries are conducted with bottom (turbot) gill nets with mesh size 360 - 400 mm. The use of bottom trawls has been prohibited. Turbot exploitation in Ukraine has been regulated by TACs since 1996.The Ukranian TAC for turbot in 2012 was 430 tons.

The Regulations of Fisheries in Ukraine determine the following standards regulating the fisheries of the Black Sea turbot:

- minimum commercial fishing size – 35 cm (SL);
- allowable by-catch of its juveniles – during the non-target fisheries not more than 2% of total catch weight, during the target fisheries with nets (with mesh size 360 mm) not more 5% by counting;
- during target long-lining of picked dogfish and Rajiformes by-catch of turbots is allowed, at the amount of not more than 20% of its juveniles by counting;
- turbot by-catch is allowed in trawl catches of sprat not more than 4 individuals a commercial fishing length per one ton of catch;
- in the period of abundant spawning of turbot in the coastal 12-mile zone a temporal prohibition for 15 – 30 days is implemented for harvesting of fish with trawls, net and long-lines (such prohibition applies to different zones at diiferent periods depending on the maturity of fish)).
- the fishing effort on turbot is limited to 7 700 gillnets(100 m each). For small vessels the minimum number of gillnets is 20. For registered vessels is 100 units.

6.2.2.3 Catches

6.2.2.3.1*Landings*

Landings data for Bulgaria and Romania were reported tothe STECF EWG 13 12through the EU Data collection program and for Turkey, Ukraine and Russia – according to the official statistics of each country. Since 2002 total annual landings varied between 528 and 1035 tons (Tab. 6.2.2.3.1.1). The data set of landings by countries was compiled for the period 1989 – 2012 with added the estimates of IUU landings.

Table 6.2.2.3.1.1 Landings and IUU estimates of turbot in the Black Sea during the period 1989 – 2012. The IUU estimated refers to the total estimated catches including unreported landings.

Year	Bulgaria	Romania	Ukraine west	Ukraine east	Turkey west	Turkey east	Russian Federation	Georgia	Black Sea total	IUU Estimated
1989	0.9	0	2	0	448	1001	0	8	1459.9	
1990	0	0	9	0	908	475	0	1	1393	
1991	0	2	17.1	0.9	600	315	0	0	935	
1992	0	1	18	1	308	110	1	0	439	
1993	0	6	10	0	400	1185	2	0	1603	
1994	0	6	18	1	1293	821	5	0	2144	
1995	60	4	10	0	2006	844	19	0	2943	
1996	62	6	37	2	1414	510	17	0	2048	
1997	60	1	40	2	777	134	11	0	1025	
1998	64	0	40	2	1056	412	14	0	1588	
1999	54	2	69	4	1579	225	15	5	1953	
2000	55.1	2	76	4	2321	318	4	9	2789.1	
2001	56.5	13	123	6	2169	154	24	11	2556.5	
2002	135.5	16.681	99	5.47	193	142	15	11	617.651	1411.60
2003	40.8	23.978	118	5.876	126	93	15	1	423.654	942.68
2004	16.2	42.031	126	7.157	118	116	1.7	7	434.088	988.67
2005	12.69	36.53	123	6	273	275	7.5	7	740.72	2039.48
2006	14.81	35.108	154	8	266	481	7.6	0	966.518	2736.91

2007	66.852	48.064	205	10.58	346	353	5.7	0	1035.396	2692.03
2008	54.621	47.112	239	12.35	224	234	4.7	0	815.786	1901.25
2009	52.47	48.767	247	16	223	119	24.3	0	730.537	1541.08
2010	46.45	48.25	166.00	41.00	218.00	77.00	25	0	621.70	1321
2011	37.80	43.25	211.00	25.00	108.10	36.40	24.09	0.00	485.64	886.80
2012	36.378	43.213	223.026	17.907	172.2	0	35.27	0	527.99	963.43

6.2.2.3.2*Discards*

No data for discards have been reported to STECF EWG 13 12. However, discards are considered to be negligible for turbot in the Black Sea. due to selectivity of the gear (400 mm mesh size for the gillnet fisheries). But turbot is also caught by otter trawl, long lines and beam trawl fishery. The by-catch of other non-target species (*R. clavata, S. acanthias, Acipenser spp*., cetacean) in turbot fishing gear could be significant. Along the Turkish Black Sea coast, about 3000 *P. phocoena* and 1500 *T. truncatus* were by-caught annually (TUDAV, 1999; Birkun, 2002). In 2010-2011 duringthe most intense turbot fishing season (April-July) direct recording of cetacean bycatches inbottom set gillnets was conducted in the central Bulgarian area. (GFCM, 2011). The bycatch index of *P. phocoena* was estimated at 22 per 100 km net set and that of *T. truncatus* – 2 per 100 km net set or overall 24 cetaceans per 100 km net set. (GFCM, 2011). However, there are no enough studies on the by-catch and discards rates of species in fishing gears, dedicated to turbot fisheries in the Black Sea.

6.2.2.4 Fishing effort

Total fishing effort data for Bulgaria and Romania (Table 6.2.2.4.1 and Table 6.2.2.4.2) were reported to EWG 13 12through the Data collection program.

Table 6.2.2.4.1 DCF total fishing effort data (kW days at sea) by gear of Bulgaria during 2008 - 2012.

Country	Year	Vessel length	Gear	Mesh size range	Fishery	Nominal effort	GT Days at sea	No vessels
BUL	2008	VL0006	SB	00D14	MDPSP	86279	7201	45
BUL	2008	VL0612	GNS	400DXX	MDPSP	13360571	1199491	244
BUL	2008	VL0612	FPO	00D14	MDPSP	16388855	155008	192
BUL	2008	VL1218	GNS	400DXX	MDPSP	538247	81346	11
BUL	2008	VL1218	OTM	00D14	SPF	1068620	146035	9
BUL	2008	VL1218	LLD	400DXX	MDPSP	1583816	218369	24
BUL	2008	VL1824	OTM	00D14	SPF	808959	204422	4
BUL	2008	VL1824	GNS	400DXX	MDPSP	514801	111688	9
BUL	2008	VL2440	OTM	20D40	SPF	4251250	2025889	11
BUL	2009	VL0006	GNS	400DXX	MDPSP	4397290	437650	246
BUL	2009	VL0006	SB	00D14	MDPSP	35948	6960	38
BUL	2009	VL0612	GNS	400DXX	MDPSP	31677082	2666531	376
BUL	2009	VL0612	FPO	00D14	MDPSP	12075037	1178437	169
BUL	2009	VL1218	GNS	400DXX	MDPSP	904853	133394	3
BUL	2009	VL1218	LLD	400DXX	MDPSP	2589388	346649	27
BUL	2009	VL1218	OTM	00D14	SPF	2957668	434558	15
BUL	2009	VL1824	OTM	00D14	SPF	1440379	376387	5
BUL	2009	VL1824	GNS	400DXX	MDPSP	663300	170129	11
BUL	2009	VL2440	OTM	20D40	SPF	5520149	2650975	12
BUL	2010	VL0006	GNS	400DXX	MDPSP	6035886	628691	290
BUL	2010	VL0006	SB	00D14	MDPSP	249121	27299	64
BUL	2010	VL0612	GNS	400DXX	MDPSP	48632062	3937369	408
BUL	2010	VL0612	FPO	00D14	MDPSP	18617358	1710535	188
BUL	2010	VL1218	GNS	400DXX	MDPSP	811362	112706	7
BUL	2010	VL1218	OTM	00D14	SPF	3559407	449947	6
BUL	2010	VL1218	LLD	400DXX	MDPSP	6027502	812014	37
BUL	2010	VL1824	OTM	00D14	SPF	1306384	351630	7
BUL	2010	VL1824	GNS	400DXX	MDPSP	632845	178907	10
BUL	2010	VL2440	OTM	20D40	SPF	6995010	3003786	13
BUL	2011	VL0006	GNS	400DXX	MDPSP	9494891	971580	302
BUL	2011	VL0006	SB	00D14	MDPSP	34136	3493	39
BUL	2011	VL0612	GNS	400DXX	MDPSP	83113602	7195983	498
BUL	2011	VL0612	FPO	00D14	MDPSP	740804	64139	87
BUL	2011	VL0612	OTM	00D14	MDPSP	180869	15660	4
BUL	2011	VL1218	GNS	400DXX	MDPSP	1133407	160684	36
BUL	2011	VL1218	OTM	00D14	SPF	5833424	827010	23
BUL	2011	VL1218	LLD	400DXX	MDPSP	679442	96325	1
BUL	2011	VL1824	GNS	400DXX	SPF	147305	42327	6
BUL	2011	VL1824	LLS	400DXX	MDPSP	36536	10498	1
BUL	2011	VL1824	OTM	00D14	MDPSP	856319	246060	5
BUL	2011	VL2440	OTM	20D40	SPF	6172300	2718507	11
BUL	2011	VL2440	GNS	400DXX	MDPSP	541	238	1
BUL	2012	VL0006	GNS	400DXX	MDPSP	5426700	513205	225
BUL	2012	VL0006	SB	00D14	MDPSP	1649473	156317	124
BUL	2012	VL0612	GNS	400DXX	MDPSP	65359376	5419588	389
BUL	2012	VL0612	FPO	00D14	MDPSP	4694659	389268	104
BUL	2012	VL0612	OTM	00D14	MDPSP	26822	2224	8

Country	Year	Vessel	Gear	Mesh size	Fishery	Nominal	GT Days	No
BUL	2012	VL1218	GNS	400DXX	MDPSP	2248723	300324	14
BUL	2012	VL1218	OTM	00D14	SPF	7499190	1001555	26
BUL	2012	VL1218	LLD	400DXX	MDPSP	85823	11462	3
BUL	2012	VL1824	GNS	400DXX	SPF	355986	92488	4
BUL	2012	VL1824	OTM	00D14	MDPSP	2080654	543064	12
BUL	2012	VL2440	OTM	20D40	SPF	5570111	2511970	10
BUL	2012	VL2440	GNS	400DXX	MDPSP	0	0	0

Table 6.2.2.4.2. DCF total fishing effort data (kW days at sea) by gear of Romania during 2008 - 2012.

Country	Year	Vessel length	Gear	Mesh size range	Fishery	Nominal effort	GT Days at sea	No vessels
ROM	2008	VL2440	GNS	400DXX	DEMF	63552	26112	4
ROM	2008	VL2440	OTM	14D16	MDPSP	193304	79424	4
ROM	2008	VL1224	GNS	100D400	DEMF	1404	453	2
ROM	2008	VL1824	GNS	400DXX	DEMF	11040	3400	2
ROM	2008	VL1824	OTM	14D16	MDPSP	16560	5100	2
ROM	2008	VL1218	GNS	400DXX	DEMF	11520	1277	4
ROM	2008	VL1218	OTM	14D16	MDPSP	2740	304	4
ROM	2008	VL0612	FPN	14D16	MDPSP	72575	32256	13
ROM	2008	VL0006	GNS	400DXX	DEMF	8031	305	12
ROM	2008	VL0612	GNS	400DXX	DEMF	1728872	146614	68
ROM	2008	VL0006	GNS	100D400	DEMF	8700	332	3
ROM	2008	VL0006	FPN	14D16	MDPSP	3198	410	4
ROM	2009	VL2440	OTM	14D16	SPF	10592	4352	2
ROM	2009	VL2440	GNS	400DXX	DEMF	4965	2040	1
ROM	2009	VL2440	GNS	100D400	DEMF	331	136	1
ROM	2008	VL0612	GNS	100D400	DEMF	1414531	119957	37
ROM	2009	VL1824	GNS	400DXX	DEMF	2429	517	1
ROM	2009	VL1824	GNS	100D400	DEMF	221	47	1
ROM	2009	VL1218	GNS	400DXX	DEMF	7801	866	3
ROM	2009	VL0612	GNS	400DXX	DEMF	3611961	306351	100
ROM	2009	VL0612	GNS	100D400	DEMF	306351	30299	36
ROM	2009	VL0612	FPN	14D16	MDPSP	113342	50377	17
ROM	2009	VL0006	GNS	400DXX	DEMF	6033	225	9
ROM	2009	VL0006	GNS	100D400	DEMF	983	42	3
ROM	2009	VL0006	FPN	14D16	MDPSP	5429	714	7
ROM	2010	VL2440	OTM	14D16	SPF	662	272	1
ROM	2010	VL0612	GNS	400DXX	DEMF	3383293	306344	124
ROM	2010	VL0612	GNS	100D400	DEMF	254657	23059	27
ROM	2010	VL0612	FPN	14D16	MDPSP	102528	45546	14
ROM	2010	VL0612	none	none	DEMSP	810	57	3
ROM	2010	VL0006	GNS	400DXX	DEMF	2519	323	3
ROM	2010	VL0006	FPN	14D16	MDPSP	2624	100	3
ROM	2011	VL2440	GNS	400DXX	DEMF	2208	645	1
ROM	2011	VL2440	OTM	14D16	SPF	27158	8012	2
ROM	2011	VL2440	OTM	14D16	MDPSP	4416	1290	1

Country	Year	Vessel	Gear	Mesh	Fishery	Nominal	GT Days	No
ROM	2011	VL1824	GNS	400DXX	DEMF	3641	965	1
ROM	2011	VL1824	GNS	100D400	DEMF	1324	351	1
ROM	2011	VL0612	LLS	none	DEMF	7137	622	4
ROM	2011	VL0612	GNS	400DXX	DEMF	4190670	154361	49
ROM	2011	VL0612	GNS	100D400	DEMF	8429	405	8
ROM	2011	VL0612	none	none	DEMSP	80851	1261	3
ROM	2011	VL0612	FPN	14D16	MDPSP	90236	26371	40
ROM	2011	VL0006	GNS	400DXX	DEMF	14039	558	6
ROM	2011	VL0006	GNS	100D400	DEMF	143	8	1
ROM	2011	VL0006	FPN	14D16	MDPSP	1727	151	8
ROM	2011	VL0006	none	none	DEMSP	777	84	3
ROM	2012	VL2440	OTM	14D16	SPF	23405	6837	1
ROM	2012	VL2440	GNS	400DXX	DEMF	5299	1548	1
ROM	2012	VL2440	-1	-1	DEMSP	883	258	1
ROM	2012	VL1824	GNS	400DXX	DEMF	3641	963	1
ROM	2012	VL1824	GNS	100D400	DEMF	993	263	1
ROM	2012	VL1218	GNS	400DXX	DEMF	5556	544	2
ROM	2012	VL1218	GNS	100D400	DEMF	926	91	2
ROM	2012	VL1218	FPN	14D16	DEMSP	695	68	1
ROM	2012	VL0612	GNS	400DXX	DEMF	633607	26041	55
ROM	2012	VL0612	GNS	100D400	DEMF	2088	114	7
ROM	2012	VL0612	LLS	-1	DEMF	1375	102	2
ROM	2012	VL0612	FPN	14D16	DEMSP	195992	52100	27
ROM	2012	VL0612	-1	-1	DEMSP	418135	59769	19
ROM	2012	VL0006	GNS	400DXX	DEMF	5705	108	8
ROM	2012	VL0006	FPN	14D16	DEMSP	2394	199	4
ROM	2012	VL0006	-1	-1	DEMSP	1956	163	3

No data were available for fishing effort and CPUE from Ukraine.

The number of fishing vessels operating in Turkish Black Sea area on turbot fisheries are given in Table6.2.2.4.3.

Table 6.2.2.4.3. Number of Turkish fishing vessels, operating on turbot fisheries in the Black Sea area.

Year	Vessels (in Nbs)
1987	102
1988	89
1989	96
1990	223
1991	94
1992	273
1993	286
1994	204
1995	166
1996	298
1997	266
1998	264
1999	338
2000	340
2001	286

Year	Vessels (in Nbs)
2002	300
2003	133
2004	141
2005	212
2006	231
2007	206
2008	263
2009	237
2010	225
2011	298
2012	362

6.2.2.5. Commercial CPUE

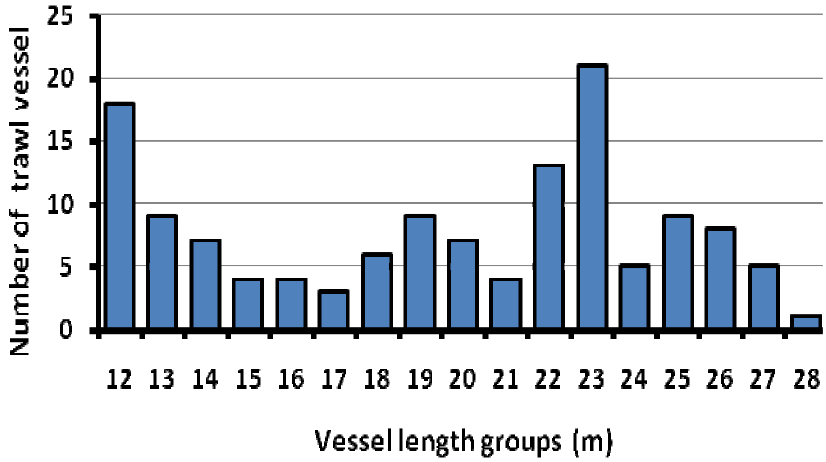
Turbot commercial fishery in Turkey is realized by two methods – gillnets fishery (70% of total landings) and by bottom trawls (30%) (Zengin et al., 1998). Thus, 38.64 t of total turbot landings in 2012are obtained by gill nets and 16.56 t by bottom trawls in Eastern Black Sea in 2012. In the Western Black Sea - 81.9 t were realizedby gillnets fishery and the 35.1 t - by bottom trawls. For both regions, the distribution of fishing effort according to the vessel length and engine power was presented in Fig.6.2.2.5.3 (a-f).

Table 6.2.2.5.1. Turbot CPUE data for Bulgaria (2008 – 2012).

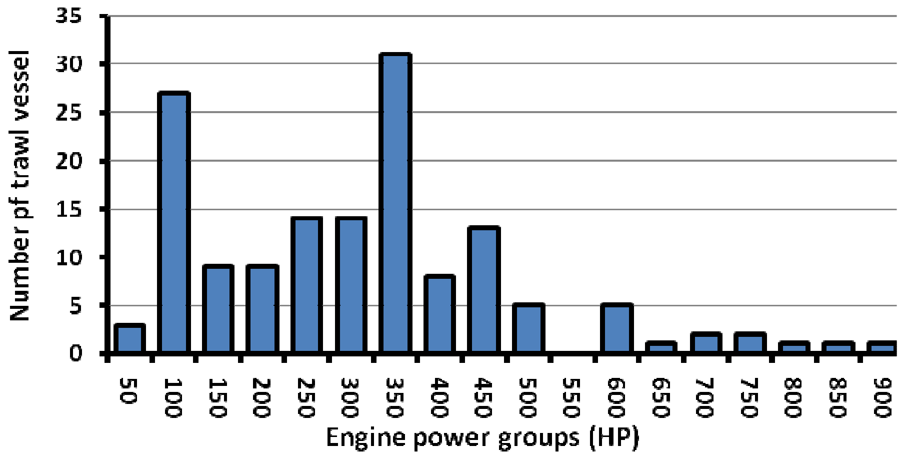
Country	**Species**	**Metier**		**CPUE**				
		Gear	**Gear**	**2008**	**2009**	**2010**	**2011**	**2012**
Bulgaria	**TUR**	**GNS**	LOA > 0 < 6	30.4	32.5	21.86	20.22	16.48
			LOA => 6<12	58.32	53.91	34.5	43.29	29.44
			LOA => 12<18	125.26	71.62	65.48	46.49	42.78
			LOA => 18<24	83.05	95.86	102.95	34.47	69.89
			LOA => 24<40	-	-	250	110.69	104.6
		OTM	LOA => 12<18	139.17	145.1	9.68	-	
			LOA => 18<24	45	137.83	--	-	
			LOA => 24<40	251.67	95	84.38	-	

Table 6.2.2.5.2. CPUE data for Romania in 2012.

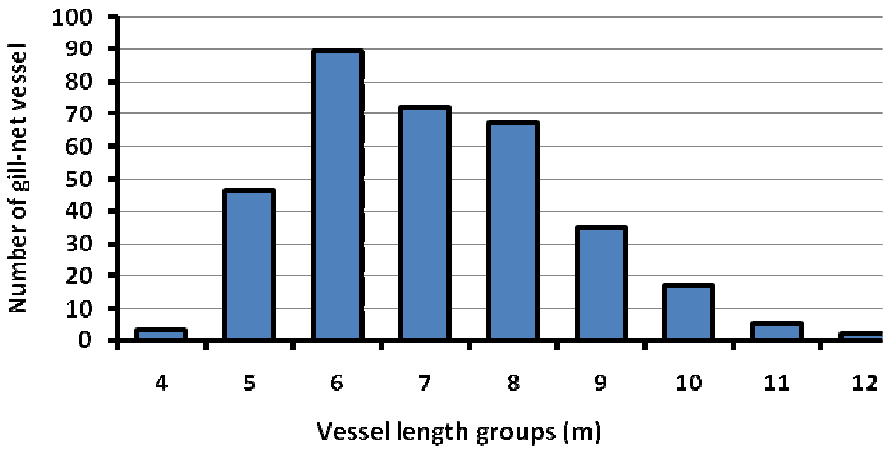
Gear	No.vessels	Landings, t	No. gillnets	Days fishing
LOA > 0 < 6	7	1.646	275	85
LOA => 6<12	55	31.678	2534	1321
LOA => 12<18	2	3.945	300	143
LOA => 18<24	1	4.250	200	31
LOA => 24<40	1	1.694	206	127
Total	**66**	**43.213**	**3515**	**1577**



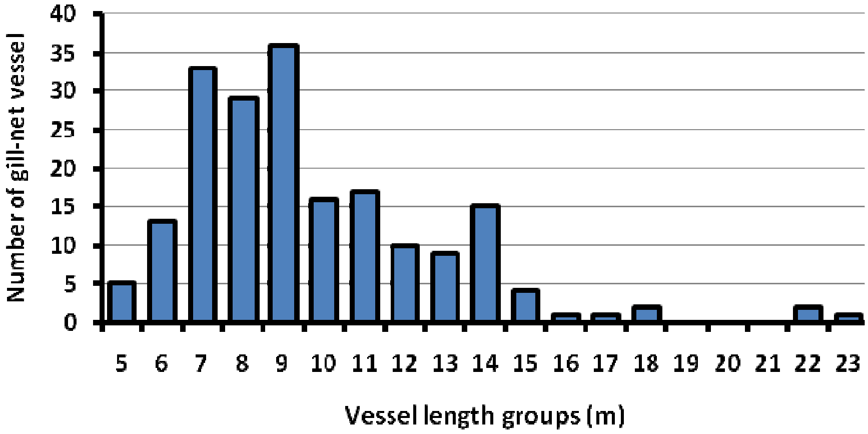
(a) East Black Sea/SSA-2012 Turkey



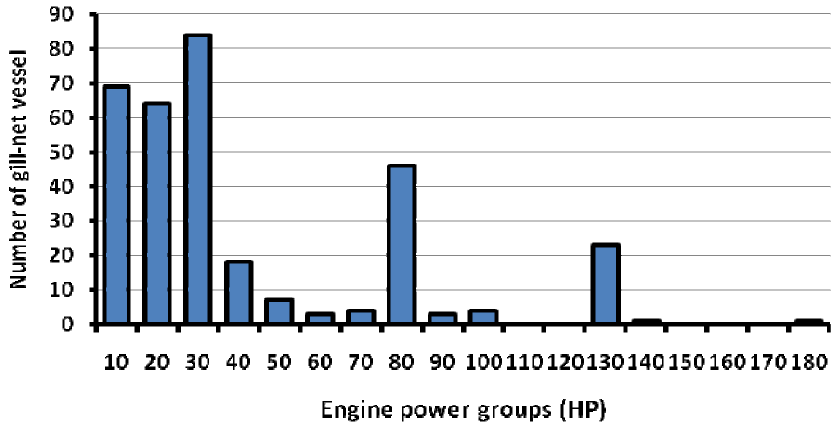
(b) East Black Sea/SSA-2012 Turkey



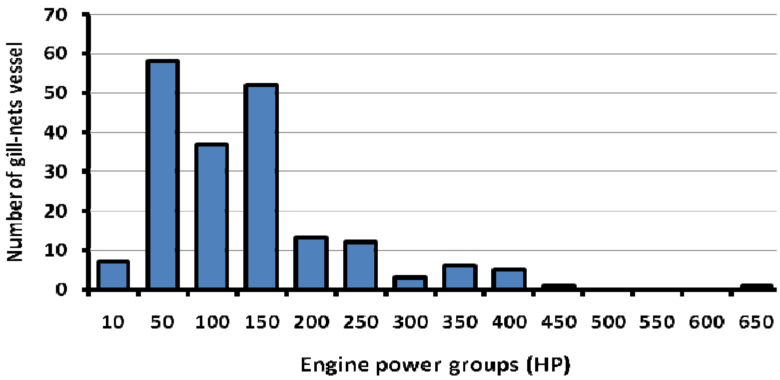
(c) East Black Sea/SSA-2012 Turkey



(d) West Black Sea-2012 Turkey

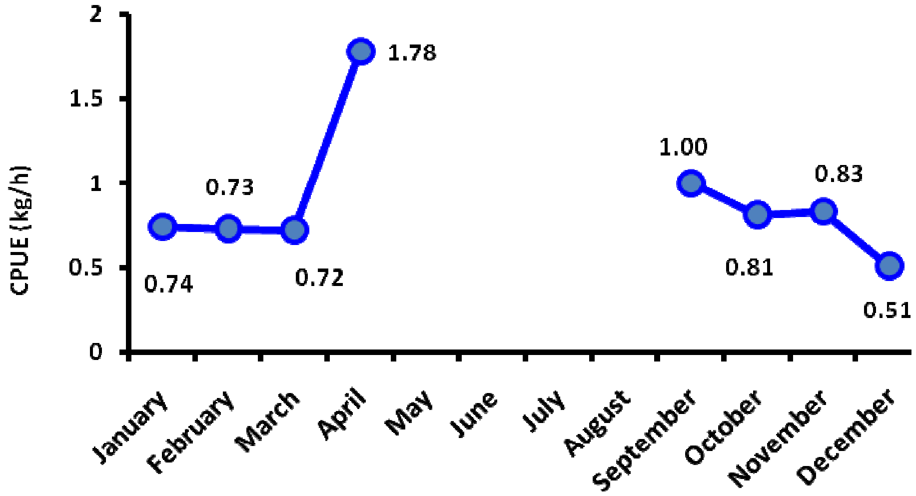


(e) East Black Sea/SSA-2012 Turkey



(f) West Black Sea-2012 Turkey

Figure6.2.2.5.3.Distribution of fishing effort in turbot fisheries by vessel length and engine power in the East and West Turkish Black Sea Region.



6.2.2.5.4.Monthly average CPUE (kg/h) of turbot for commercial trawl in the Turkish Black Sea area.

6.2.3 *Scientific Surveys*

6.2.3.1 Method 1: International (Bulgarian and Romanian) Bottom Trawl Survey

Demersal trawl surveys in Community waters (Bulgaria and Romania) were executed in accordance with national Data collection programs of Bulgaria and Romania for 2012. Surveys were aimed to assess the turbot abundance and biomass indices. Two of them were executed in Romanian Black Sea area in spring and autumn seasons and one - in Bulgarian marine area. All studies from 2010 up to date in EU waters are performed with the same vessel and equipment.

Surveys apply standard methodology for stratified random sampling(Sparre, Venema, 1998; Sabatella, Franquesa, 2004) and swept area method. The method is based on bottom trawling across the seafloor (area swept) and is widely used as a direct method for demersal fish stock assessment when only an index of abundance is required. The seabed area covered during a single haul represents a basic measurement unit, which although very small compared to the total study area is deemed representative since turbots do not aggregate in dense assemblages. The fields are grouped in larger sectors – so called strata, with geographic and depth boundaries selected according to the density distribution of the species.The research area was divided in four strata according to depth: Stratum 1 (15 – 35 m), Stratum 2 (35 – 50 m), Stratum 3 (50 – 75 m) and Stratum 4 (75 – 100 m). The total number of hauls in 2012 are given on Table 6.2.3.1.1.

Table 6.2.3.1.1. Number of hauls per depth stratum and countryin 2012.

Country	Period	Stratum	Number of hauls
BGR	May	15 - 35 m	5
		35 - 50 m	10
		50 - 75 m	15
		75 - 100 m	10
ROU	May	15 - 35 m	18
	October	35 - 50 m	29
		50 - 75 m	31

6.2.3.1.1. Geographical distribution patterns

Three areas with high values of relative biomass were observed in front of Bulgarian coast – small area in front of Kamen bryag at depths between 50 -60 m, larger area off Varna (depths 30 – 55 m) and the largest area with high values of relative biomass in front of cape Maslen nos, covering depths from 15 to 75 m. In these areas, relative biomass index ranged between 3.09 t.km^{-2} and 10.49 t.km^{-2} (Panayotova, Raykov , 2013).
Low values of turbot relative biomass were established for the rest of the area.
All areas with higher estimated relative biomasses were in the layer, embracing depths between 35 – 75 m.

Stratum 15 - 35 m

Relative biomass of turbot in this stratum was very low with values ranged between 0 and 3.67 t.km^{-2}, at average1.12 t.km^{-2}(Fig.6.2.3.1.1.1).

Stratum 35 - 50 m

Turbot relative biomass here was the highest with values ranging from 0 and 10.49 t.km^{-2}, at average 2.56 t.km^{-2}(Fig.6.2.3.1.1.1).

Stratum 50 - 75 m

The relative turbot biomass in this stratum ranged between 0 and 8.70 t.km^{-2}, with average value of 1.66 t.km^{-2} (Fig.6.2.3.1.1.1).

Stratum 75 - 100 m

In this stratum relative biomass varied between 0 and 4.86 t.km^{-2} with average value of 0.68 t.km^{-2} (Fig.6.2.3.1.1.1).

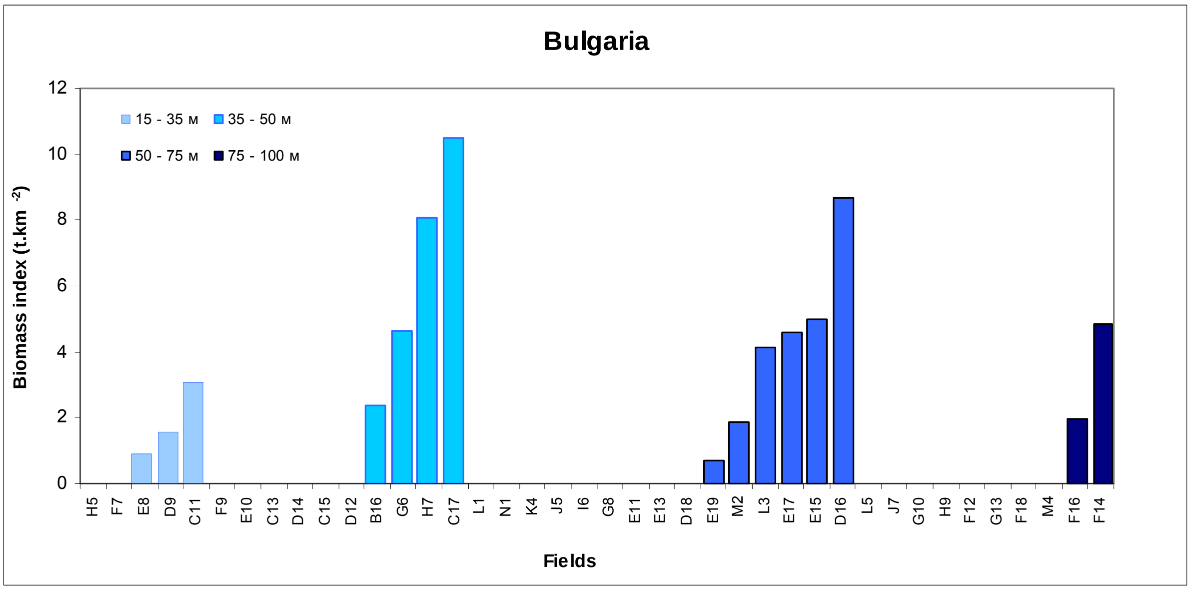


Figure 6.2.3.1.1.1 Relative biomass of *S. maximus*by strata in front of Bulgarian Black Sea coast in May 2012 (Panayotova, Raykov , 2013).

Distribution of turbot CPUA (kg.km^{-2}) forthe Bulgarian waters in spring season is shown inFig. 6.2.3.1.1.2. The maxima of CPUA during the survey was observed in front of cape Maslen nos with value of 167.69 kg.km^{-2} at depths around 40 - 45 m. Higher values of catches per unit area were observed off Varna area. In the northern region, another area with higher CPUAs was observed in front of Kamen bryag. In the southern region, the maximum values of CPUA were concentrated in the area enclosed between depths 40 m and 75 m in front of cape Maslen nos. The average estimated CPUA value for the whole Bulgarian area during the survey was 25.15 kg.km^{-2}(Panayotova, Raykov , 2013).

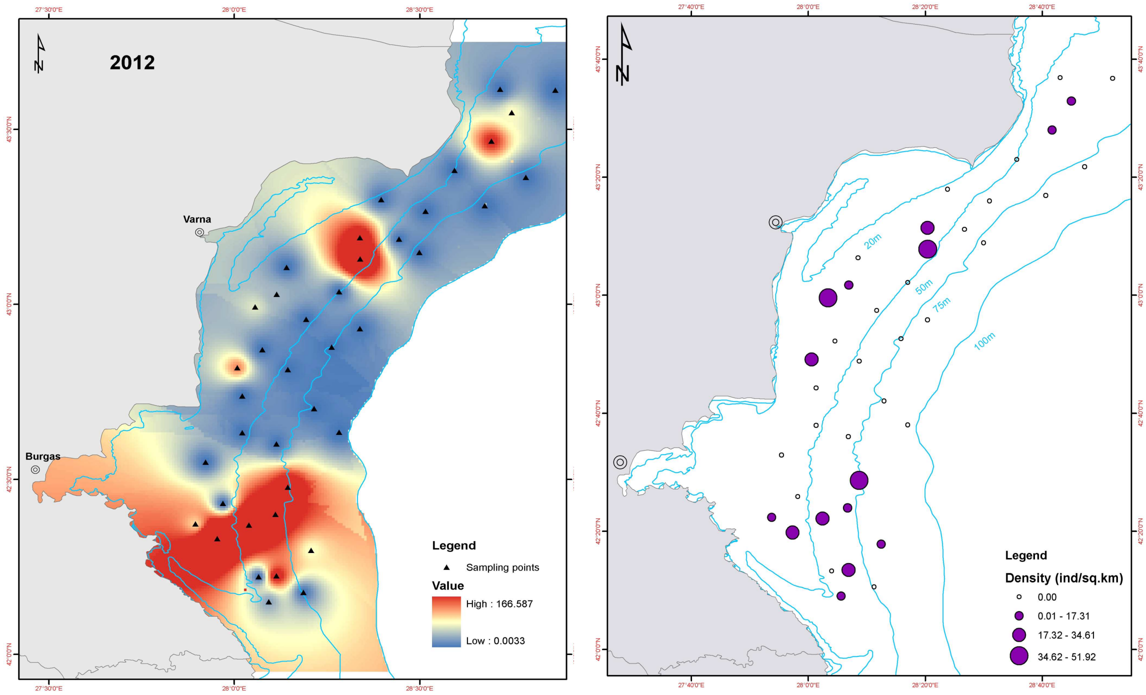


Figure 6.2.3.1.1.2. Distribution of turbot CPUA (kg/km^2) and density, obtained from research survey along the Bulgarian Black Sea coast in May 2012 (Panayotova, Raykov , 2013)).

The biomass of the main fish species with commercial value along Romanian Black Sea coast was asessed by swept area method. During the research survey in spring season, the turbot population was wide distributed in the area between Mangalia and Sulina, with a higher density between Vama Veche – Constanta. The agglomerations reached an average value of 0.108 - 167 t/nm^2 (Maximov et al, 2012).

During the 40 hauls covering the area of 2 245.99 nm^2; the distribution of turbot agglomerations was variable. The average values of the turbot catches ranged between 0,001 t/nm^2 and 1.782 t/nm^2. Significant catches were recorded between 35 and 50 m depth, in the Corbu - St. Gheorghe (the change of abundance 0.167 t/nm^2). During the spring survey, the turbot biomass was estimated at 627.35 tones in the studied area of 2 245.99 nm^2, (Table 6.2.3.1.1.1).

Table6.2.3.1.1.1Assessment of turbot agglomerations in t May 2012, demersal trawl survey , Romanian area.

Depth range (m)	**0 - 30m**	**30 – 50m**	**50-70 m**	**Total**
Investigated area (Nm^2)	663.62	1065	517.37	2245.99
Variation of the catches (t/ Nm^2)	0.00-0.45	0.00-0.68	0.00-0.47	0.00-68
Average catch (t/ Nm^2)	0.142	0.167	0.108	
Biomass of the fishing agglomerations (t)	94.28	178.648	56.051	328.98
Biomass extrapolated the Romanian shelf (t)				**627.35**

In autumn season, 38 demersal trawlings were conducted on an area of 2 555.75 nm^2. The observed distribution of turbot agglomerations was different, compared to spring season. The average values of turbot catches varied between 0.056 and 0.147 t/nm^2. Higher catches have been recorded between 30 and 50 m depth in Corbu –

Sulina and Costinesti – Vama Veche. In autumn survey, the estimated turbot biomass was 627.35 tones for the area of 2 245.99 nm^2, (Table 6.2.3.1.1.2).

Table 6.2.3.1.1.2. Assessment of turbot agglomerations in the period October -November 2012, demersal trawl survey , Romanian area.

Depth range (m)	**0 - 30m**	**30 – 50m**	**50-70 m**	**Total**
Investigated area (Nm^2)	607.75	930.5	1017.5	2555.75
Variation of the catches (t/ Nm^2)	0.00-0.192	0.00-0.408	0.00-0.37	0.00-0.41
Average catch (t/ Nm^2)	0.056	0.147	0.089	
Biomass of the fishing agglomerations (t)	34.07	137.065	91.056	262.19
Biomass extrapolated the Romanian shelf (t)				**480.91**

Distribution of turbot CPUA ($kg.nm^{-2}$) in Romanian waters by seasons (Maximov et.al, 2013) is shown on Fig. 6.2.3.1.1.3.

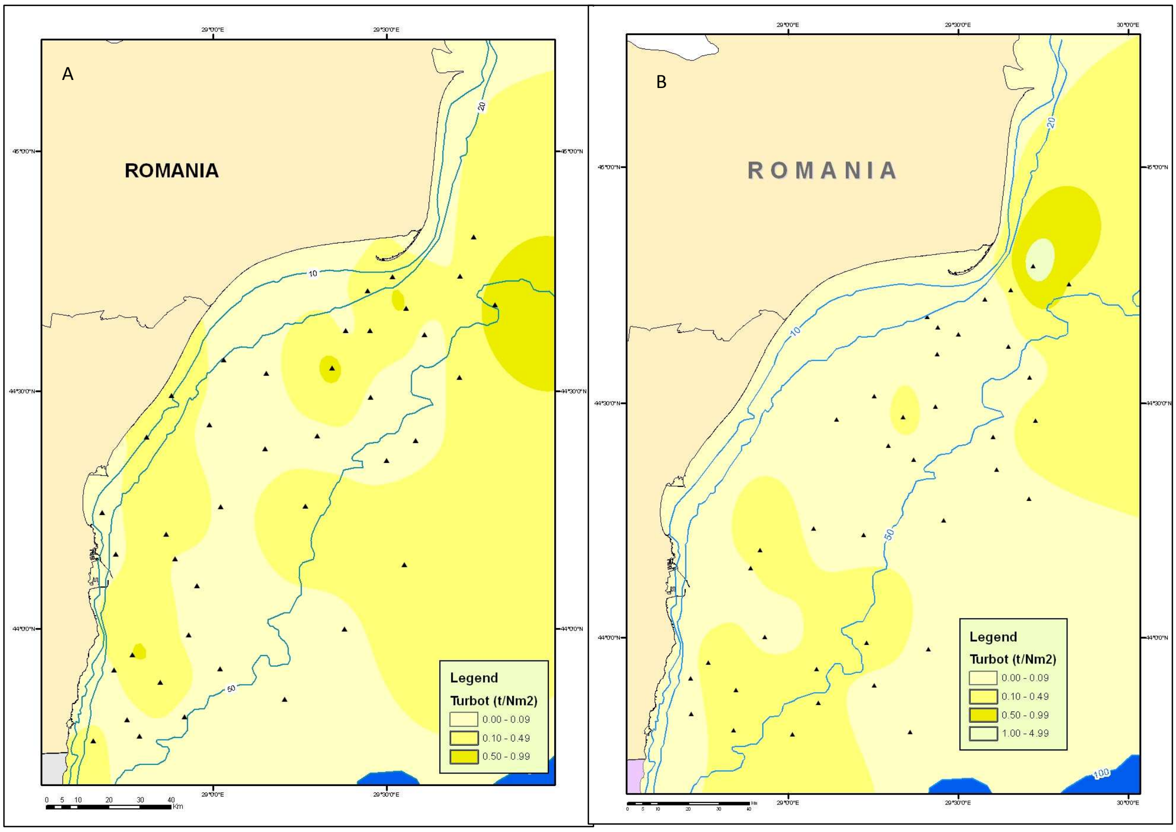


Figure 6.2.3.1.1.3. Distribution of turbot CPUA (kg/Nm^2) from surveys along the Romanian Black Sea coast in spring (A) and autumn (B) seasons of 2012 (Maximov et.al, 2012).

6.2.3.1.2. Trends in abundance and biomass

The collection of fishery independent information regarding the state of the turbot stock in the EU waters continues in 2012 troughresearch surveys in Bulgarian (Panayotova et.al, 2013) and Romanian(Maximov et. al., 2013) areas under Data Collection Program. Fig. 6.2.3.1.2.1 shows the trends in the estimated biomass indicesfor Bulgaria and Romania(Maximov et al, 2006, 2008, 2009; Maximov et al, 2010a, Maximov et al, 2010b; Radu et al, 2009a; Radu et al, 2009b, Radu et al, 2010a; Radu et al, 2010b, 2011, 2012; Panayotova et.al., 2006, 2007a, 2007b, 2008a, 2008b, 2009, 2010, 2011a, 2011b, 2012, 2013). The biomass indexcontinues to decrease in Bulgarian area with the lowest value of 191.47 t in 2012. Same decreasing trend was observed in Romanian area in 2012.

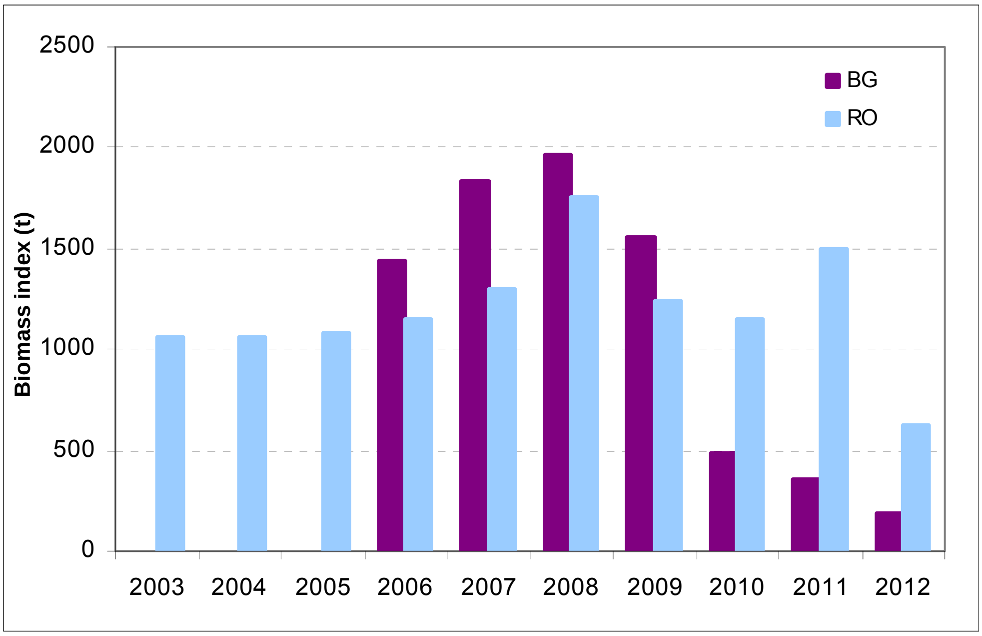


Fig. 6.2.3.1.2.1. Biomass indices derived from national surveys in Bulgaria and Romania) for turbot in the Black Sea in the period 2003 - 2012.

6.2.3.1.3. Trends in abundance at length or age

The observed size and age distributions of turbot catches during the survey in May, 2012 along the Bulgarian Black Sea coast are presented on Fig. 6.2.3.1.3.1. Due to very low number of individuals caught (n=26), the observed distributions are not representative for the population in front of Bulgarian coast. The individuals caught have lengths between 26 and 70 cm. Undersized turbots with total lengths under 45 cm represent 38.46 % of all caught specimens and the standard sized fish represent 61.54 % respectively. The average length over all caught specimens was estimated at 47.10 cm. The maxima in abundance were observed in size classes 44.5 – 53.5 cm, but all classes were low abundant. The larger size classes were represented by few individuals, which make up 19.23 % of total observed abundance.

Age structure of specimens caught in the Bulgarian area encompassed 2 - 7 years old individuals. The catches were dominated by 4 - years old fish (30.77%) - Fig. 6.2.3.1.3.1. During the survey in May 2012, the share of recruitment (2 - 3- years old individuals) represent 34.62 % from all caught fish, the 4 - 5 years old fish- 46.15% and the 6 - 7 years old individuals composed 19.23 % of total abundance.

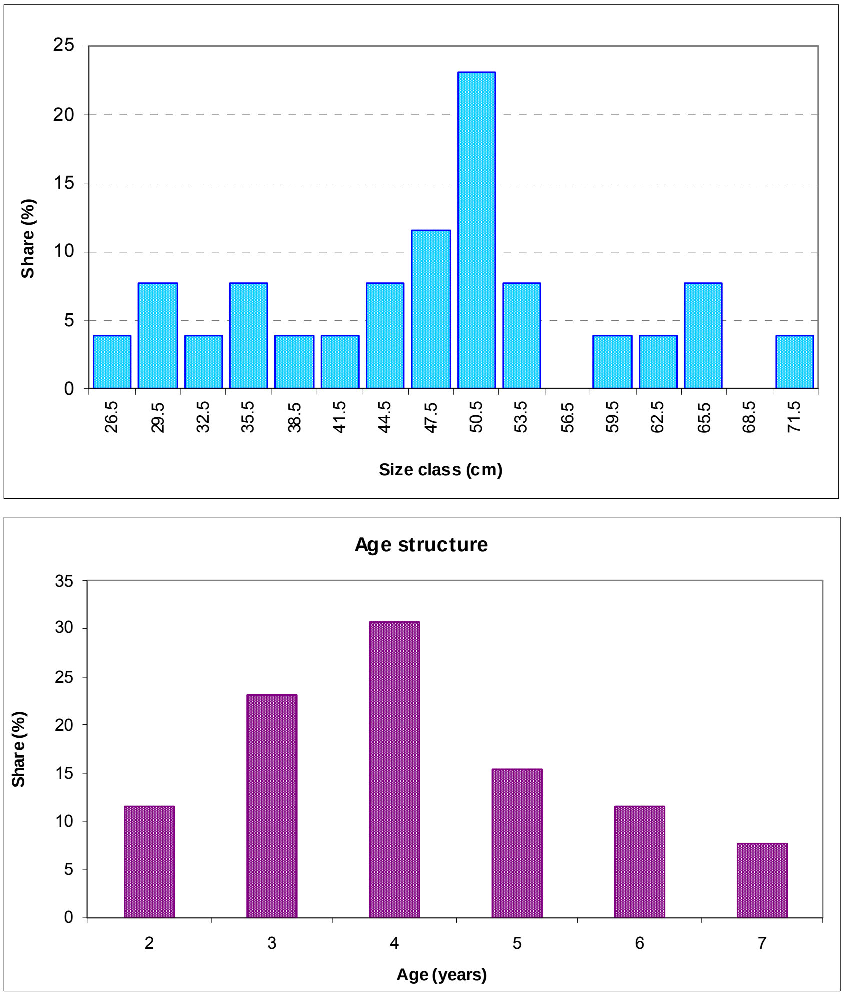
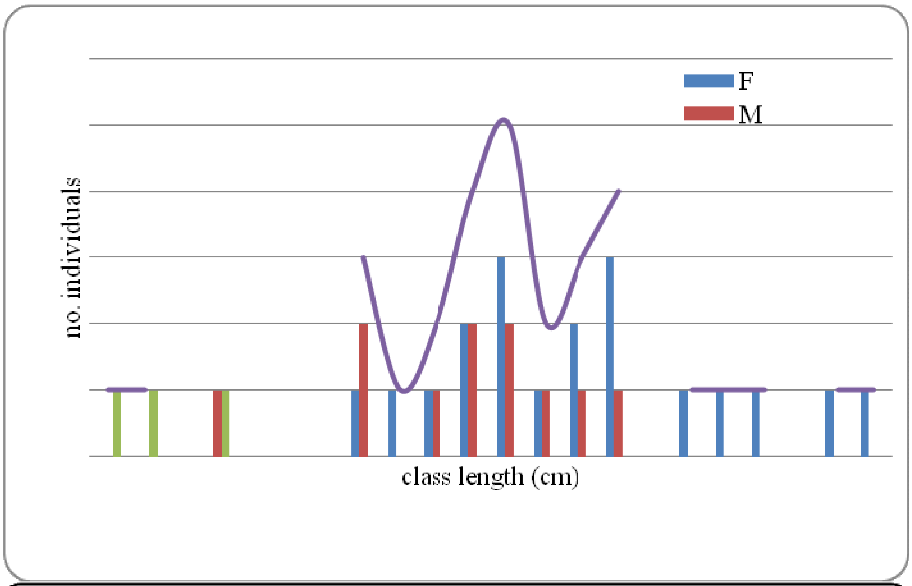


Figure 6.2.3.1.3.1. Length and age frequency data for turbot, obtained during the survey along the Bulgarian Black Sea coast in May, 2012 (Panayotova et al, 2013).

In Romanian area, the turbot catches were low in spring survey 2012. The size structure was composed of mature specimens with total lengths beteen 21 - 81 cm / 633.0 – 9155.0 g, aged 2-7 years. The dominant size classes were 41.5 - 68.5 cm / 1,650 - 5,507.27 g, 3 - 5 years (76.0%). Average body length was estimated at 54.44 cm and the average weights - 3 425.24 g, respectively. The sex ratio indicates a clear dominance of females (53.96%) than males (43.56%) and juveniles (2.48%). The age composition of turbot catches reveals the existence of specimens between 1 to 7 years. Most of the individuals are 4 years old (31% of all specimens analyzed) and of 3 years old (30%), followed closely by those of 5 years old (15%), 6 years (9%), 7 years (8%) and of 2 years old (7%)(Maximov 2012).

The size and age structure of turbot catches during the spring and autumn surveys in Romanian area in 2012 are presented on Fig. 6.2.3.1.3.2 and Fig. 6.2.3.1.3.3.



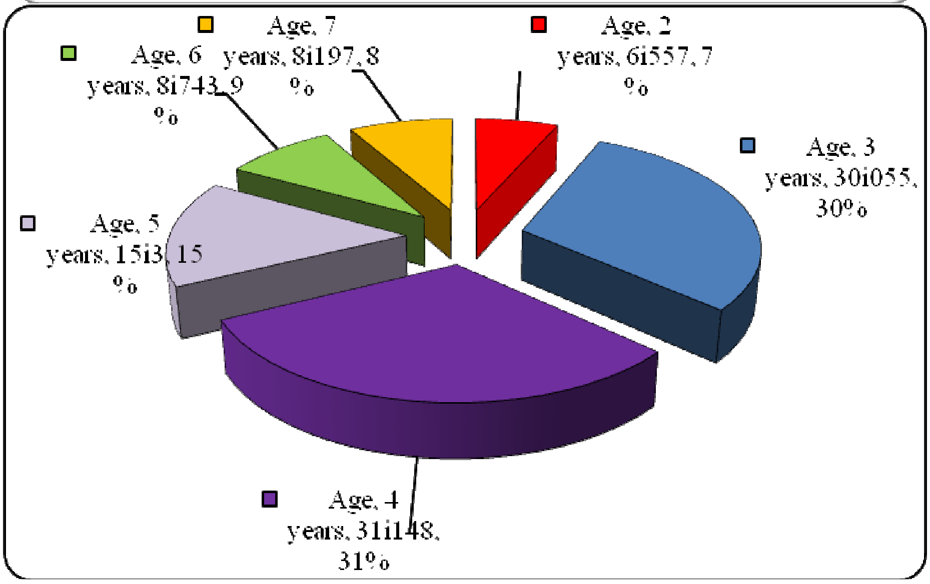


Figure 6.2.3.1.3.2. Size and age structure of turbot, obtained during the spring survey along the Romanian Black Sea coast in 2012.

During the autumn survey in 2012, thecatches were composed by specimens with lengths of 17.5 – 71.5 cm / 400.0 – 6 410.12 g. The the dominant size classes were 50.5 - 68.5 cm / 2 289,21 – 4 854.14 g (Figure 6.2.3.1.3.3). Average body length was estimated at 54.36 cm and the average weight– 3 299.75 g. The sexratio indicates a clear dominance of females (52.5%) than males (36.25%) and etween 1 to 6 years. Most of the individuals are 4 years old (26% of all specimens analyzed) and of 5 years old (25%), followed closely by those of 6 years (19%), 3 years (19%), and of 2 years old (11%)(Maximov 2012).

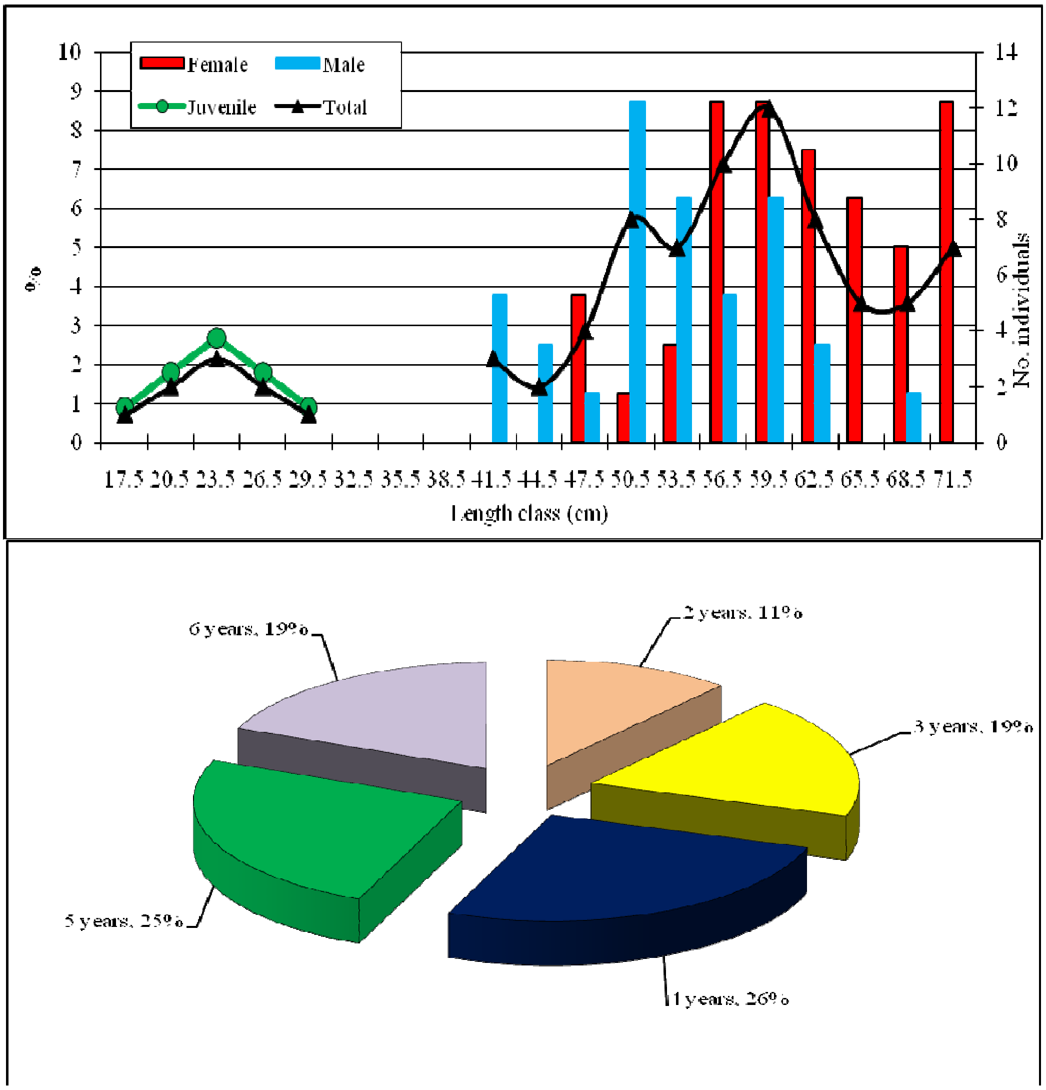


Figure 6.2.3.1.3.3. Size and age structure of turbot, obtained during the autumn survey along the Romanian Black Sea coast in 2012.

6.2.3.1.4. Trends in growth

Due to very low number of caught turbots (n=26) in Bulgarian area, statistically reliable estimation of growth rate during the spring season of 2012 could not be obtained. The calculated values of the parameters in von Bertalanffy growth function, estimated by least square method are given in Table 2.6.3.1.4.1.The linear growth of both genders in 2012 at age 2 – 7 years old is according to the relationship represented on Fig. 4.6.3.

Table 2.6.3.1.4.1. Values of parameters in VBGF for both genders.

Parameters	VBGF
L_∞ (cm)	125.597
k	0.104
t_0	-0.516
a	0.000017750
b	3.004

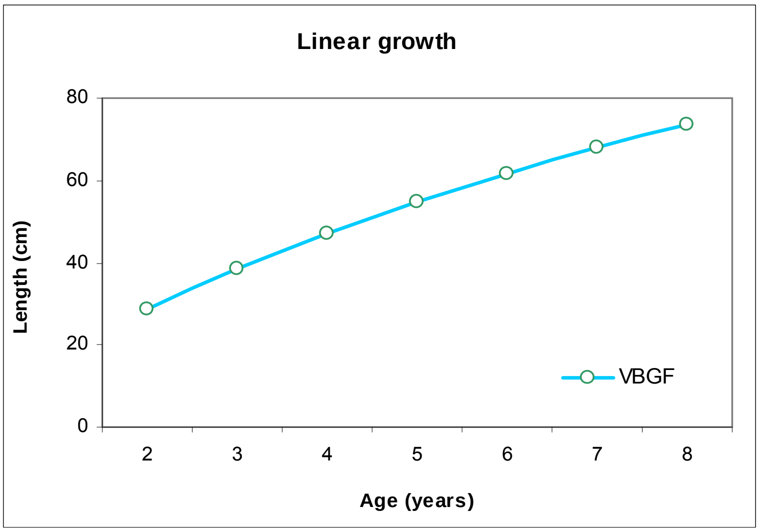


Figure2.6.3.1.4.1. Linear growth of turbot by ages.

6.2.3.1.5. Trends in maturity

No analyses were conducted.

6.2.3.2 Method 2: Survey with Turkish commercial fishing vessels

The survey was executed along Samsun shelf area (East Black Sea) and West Black Sea during the fishing season from 15 September to 30 December and from 1 January to 15 April in 2012. It is converged 7 months. The trawl sampling was conducted between depths of 50-100 m (minimum 24.7 m, maximum 113.1 m). The samplings was done randomly and swept area was applied.

6.2.3.2.1*Geographical distribution patterns*

In 2012, survey on commercial fishing vessels was executed in Turkey.Estimated biomass indices of pooled data for the Eastern and Western Turkish Black Sea are given on Fig. 6.2.3.2.1.1.

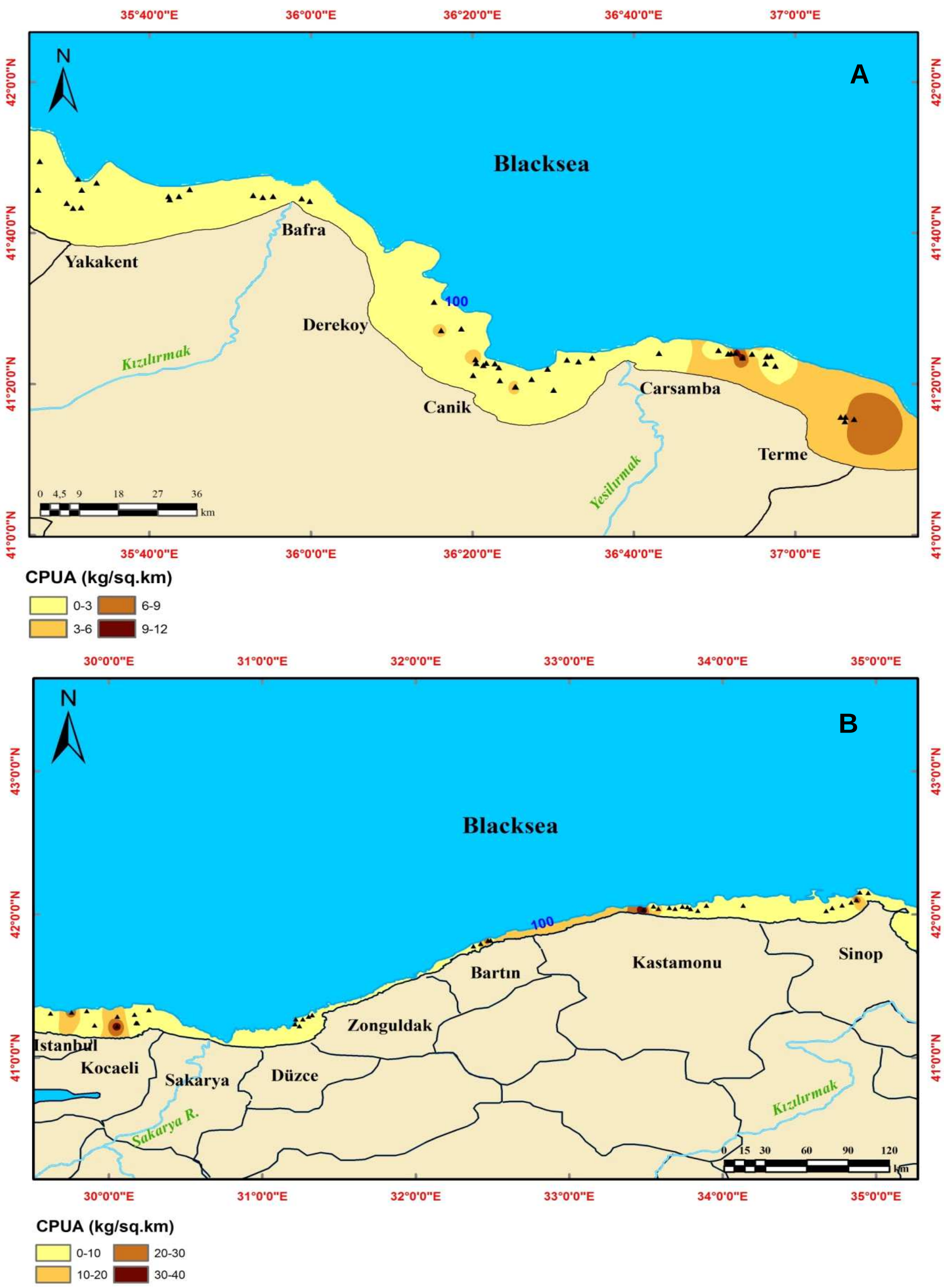


Figure 6.2.3.2.1.1Distribution of turbot CPUA (kg.km-[2]) from surveys along the Turkish East (A) and West (B) Black Sea coast in 2012 (Zengin, Gumus, 2013).

6.2.3.2.2*Trends in abundance and biomass*

The estimated catch per unit effort (CPUE) and biomass indices (CPUA) for the Turkish area during the autumn, winter and spring seasonsin the active period for bottom trawls in both regions (turbot fishery is allowed between 15 September and 15 April and out of 3 miles), are presented in Table 6.2.3.2.2.1.

Table 6.2.3.2.2.1Turkish Black Sea turbot catch per unit effort (kg/h) and biomass indices (kg/km^2) in 2012.

Region	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CPUE/GENERAL	101	0.00	6.10	0.78	0.13	1.27
CPUA/GENERAL	101	0.00	12.79	1.66	0.28	2.81
CPUE/SSA (EBS)	59	0.00	6.10	0.90	0.17	1.32
CPUE/ WBS	42	0.00	4.00	0.61	0.19	1.19
CPUA/ SSA (EBS)	59	0.00	12.79	1.88	0.38	2.92
CPUA/WBS	42	0.00	8.73	1.36	0.41	2.65

The mean abundance index is estimated as 1.66±0.28 kg/km2 in trawl hauls in depths between 50-100 m (minimum 24.7 m, maximum 113.1 m) along Samsun shelf area in spring 2012 (Table 6.2.3.2.2.1). Abundance indices were estimated by 'swept area method' for the period of intense fishing (January-April and September-December) from commercial vessels (Sparre and Venema, 1992).

6.2.3.2.3*Trends in abundance at length or age*

The average length (Fig.6.2.3.2.3.1) and weight frequency distributions were presented in Table 6.2.3.2.3.1**.** The age range was determined as 0-8 years.

Table 6.2.3.2.3.1.The age, average length and body weight distributions of turbot for Turkish Black Sea Coast in2012.

Age group	Length (cm)	Weight (g)	N
0	7.5	6.6	1
1	21.1	165.2	7
2	28.6	462.2	17
3	37.8	926.3	17
4	42.9	1374.9	29
5	49.1	2014.4	23
6	57.1	3190.0	2
7	63.3	4831.3	4
8	68.1	6216.7	3
Average	41.3±11.12 (7.9-69.0)	1506.4±1286.91 (6.6-7050.0)	101

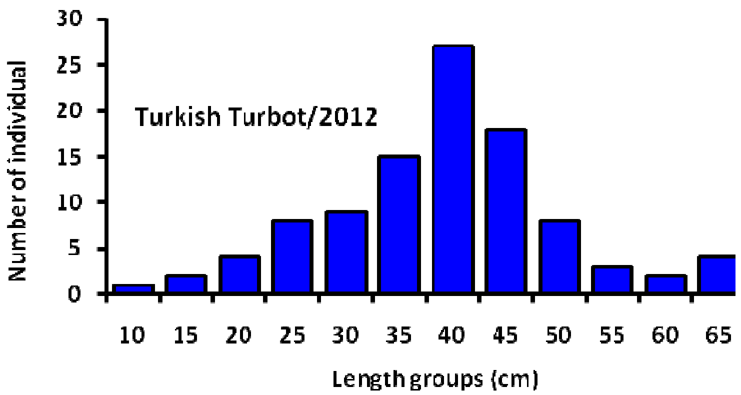


Figure 6.2.3.2.3.1. The length frequency distribution of turbot population along Turkish Black Sea Coasts, 2012.

6.2.3.2.4 *Trends in growth*

The growth parameters were estimated as $L_{oo=}$ 82.41 cm, K=0,342 year^{-1} and t_0=-3.731 year and the constant and slope in length-weight relationship were calculated as 0,012 and 3,093 (Rsq= 0.99) respectively, for spring sampling 2012 (Fig.6.2.3.2.4.1)

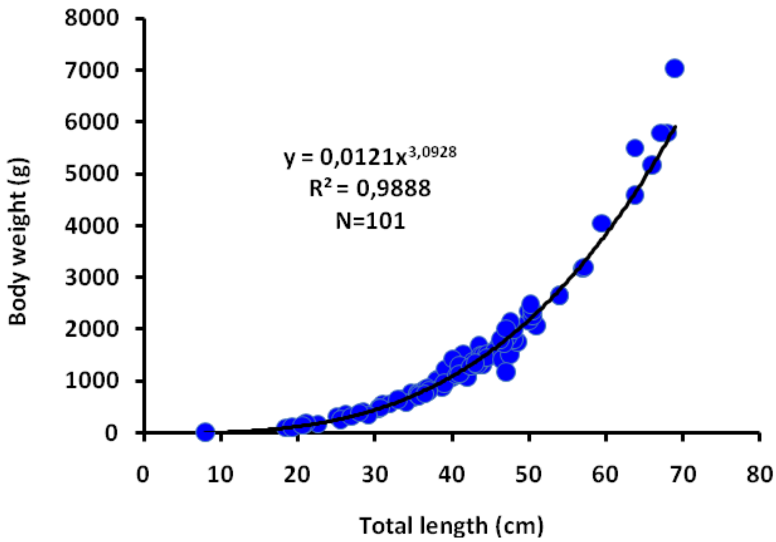


Figure 6.2.3.2.4.1. Turbot length-weight relationship in 2012.

6.2.3.2.5 *Trends in maturity*

No analyses were conducted.

6.2.4 *Assessment of historic parameters*

6.2.4.1 Method 1: SAM

6.2.4.1.1 *Justification*

The data set for the period 1950-2012 was compiled using the historical data sources (Ivanov, Beverton, 1985; Ivanov, Karapetkova, 1979; Prodanov et. al, 1997, Daskalov et.al, 2012) and new data for 2012. Available data of total landings, catch at ages, weights and maturity at age are considered appropriate for assesseng the stock using thestate-space assessment model (SAM)(Nielsen et al., 2012) in FLR environment. The SAM environment is encapsulated into the Fisheries Library in R (FLR) (Kell et al., 2007) in the form of the package “FLSAM”. The state-space assessment model (SAM) is an assessment model which is used for several assessments within ICES and it has been used for the assessment of Black Sea turbot in 2012. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects. All assessments are performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore). Five tuning series (4 surveys and 1 commercial CPUE series were compiled from previous assessments (Daskalov et al., 2012) and recent data. In 2012, an historical survey covering the Eastern part of the Ukranian Black Sea area was compiled and used in the assessment.

6.2.4.1.2 *Input parameters*

Input data types and characteristics are given in Tabl.6.2.4.1.2.1.

Table 6.2.4.1.2.1. Input data, used in SAM.

Name	Type	Year range	Age range	Data Modifications	Variable from year to year?
$LA_{(1)}$	catch in tonnes	1950 - 2012	2 - 10+	See note 1	Yes
$CN_{(2)}$	catch-at-age in numbers	1950 - 2012	2 - 10+	See note 2	Yes
$CW_{(3)}$	Weight-at-age in the commercial catch	1950 - 2012	2 - 10+	See note 3	Yes
$SW_{(3)}$	Weight-at-age of the spawning stock	1950 - 2012	2 - 10+	See note 3	Yes
$NM_{(4)}$	natural mortality	1950 - 2012	2 - 10+	See note 4	Yes
PF	proportion of fishing mortality before spawning	1950 - 2012	2 - 10+	No	No
$MO_{(5)}$	Proportion mature-at-age	1950 - 2012	2 - 10+	See note 5	Yes
PM	proportion of natural mortality before spawning	1950 - 2012	2 - 10+	No	No
	West Ukrainian survey	1989 - 2007	4 – 10+	No	No
	East Ukrainian survey	1989 - 2006	2 – 10+	No	New
TUN	Romanian survey	2003 - 2012	4 - 9	Yes	Yes
	Bulgarian survey	2006 - 2012	2 - 7	Yes	Yes
	Turkish commercial CPUE	1987 - 2012	2 - 10+	Yes	Yes

(1) Assessment and qualitative assumptions about the IUU (Illegal, Unregulated and Unreported) fishing of turbot were made and rates of the Potential Unreported Catch in 2002-2010 were estimated as a proportion between Turkish catch in 1993-2001 and 2009-2010, which then was added to the officially reported catch. The IUU catch in 2012 was estimated as average from proportions in 2002-2009 (Table 6.2.2.3.1.1).

(2) Catch-at-age data for 2012 are derived from the raised national landings statistics by countries and added to thehistoric catch at age data set compiled during the previous meetings. The catch-at-age data was corrected to the official landings (SOP corrections). They do represent officially reported landings and do not include any discards but they do take into account the IUU catches during the period 2002 - 2012.

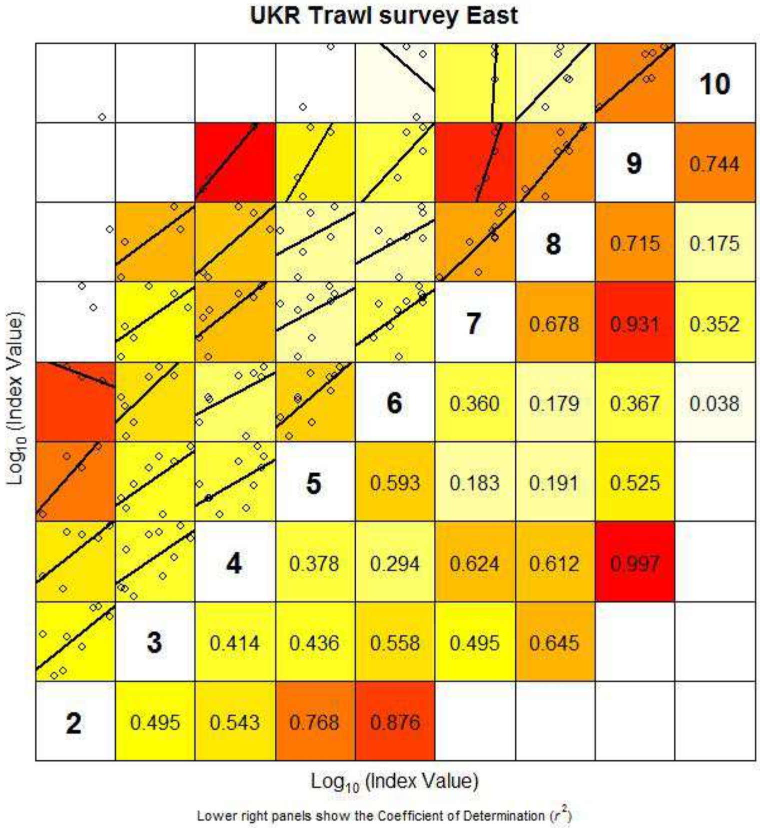
(3) The mean weights at ages in the stock for the period 1989-2011 were assumed equal to the catch weights at age in the landings due to lack of data. The averaged weights-at-age during the period 1989 – 1993 were used to estimate weight at age in 1950 – 1988.

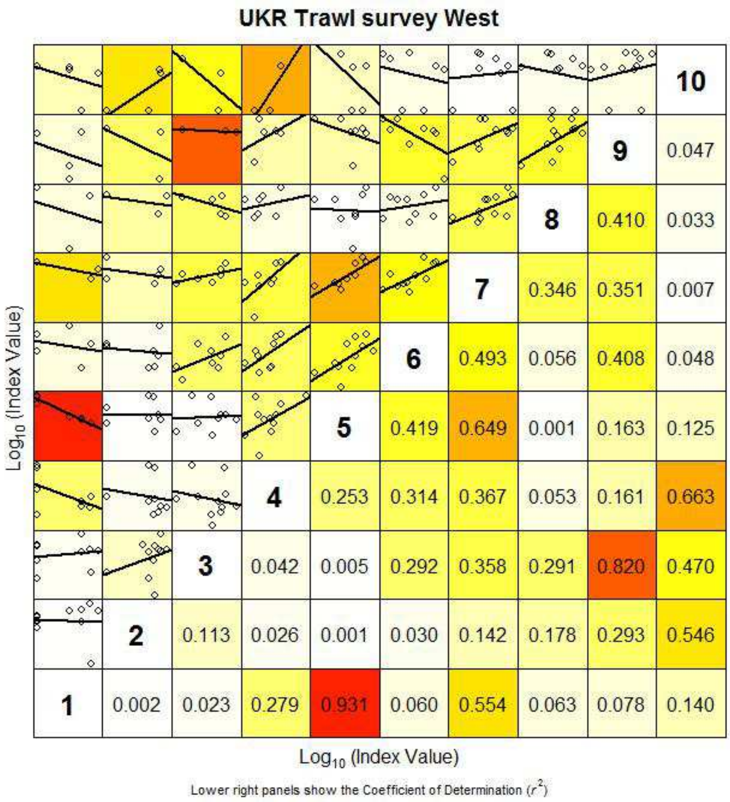
(4) A vector of natural mortality (M) by age groups was estimated by ProdBIOM ver.2009 (Abella et.al, 1997, 1998) using different sets of parameters in VBGF (Table6.2.1.2.1) estimated for the historical and the modern part of the time series.

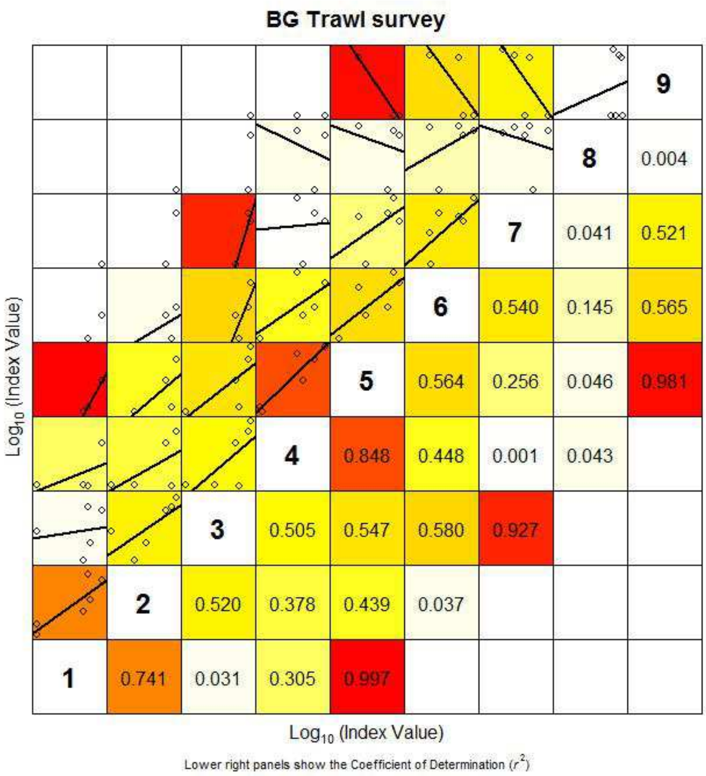
(5) Maturity ogive was calculated as the average for the period 2007 – 2009 due to good consistency for these years and applied over the whole period.

Prior to different assessment runs, the exploration analysis of the data was performed and data was assessed as appropriate for stock assessment purposes. The analyses of tuning series is shown on Fig.6.2.4.1.2.1.The full set of figures of the exploration data analysis are presented in the Appendix 1.

STECF EWG 13 12 considered touse all of the 5 seriesfor tuning the SAM model, obtained from Bulgarian, Romanian and Ukrainian fishery-independent surveys and CPUE ofthe Turkishfleet, for ages, selected from the data exploration analysis covering the period 1987-2012. Internal consistency plots were used to select the surveys and age classes within each survey to be used in the SAM model. The ages selected for each of survey are reported in table 6.2.4.1.2.1. The exploration analysis selected the ages 4 – 9 from Romanian survey, ages 4 – 10 – from Ukranian West, 2 – 10 from Ukrainean East, 2- 7 – from Bulgarian survey and ages 2 – 10 from Turkish commercial CPUE (Fig. 6.2.4.1.2.2, Table 6.2.4.1.2.1).




UKR Trawl survey West
Log10 (Index Value)
Log10 (Index Value)
Lower right panels show the Coefficient of Determination (r2)
1
2
3
4
5
6
7
8
9
10
0.002 0.023 0.279 0.931 0.060 0.554 0.063 0.078 0.140
0.113 0.026 0.001 0.030 0.142 0.178 0.293 0.546
0.042 0.005 0.292 0.358 0.291 0.820 0.470
0.253 0.314 0.367 0.053 0.161 0.663
0.419 0.649 0.001 0.163 0.125
0.493 0.056 0.408 0.048
0.346 0.351 0.007
0.410 0.033
0.047


BG Trawl survey
Log10 (Index Value)
Log10 (Index Value)
Lower right panels show the Coefficient of Determination (r2)
1
2
3
4
5
6
7
8
9
0.741 0.031 0.305 0.997
0.520 0.378 0.439 0.037
0.505 0.547 0.580 0.927
0.848 0.448 0.001 0.043
0.564 0.256 0.046 0.981
0.540 0.145 0.565
0.041 0.521
0.004

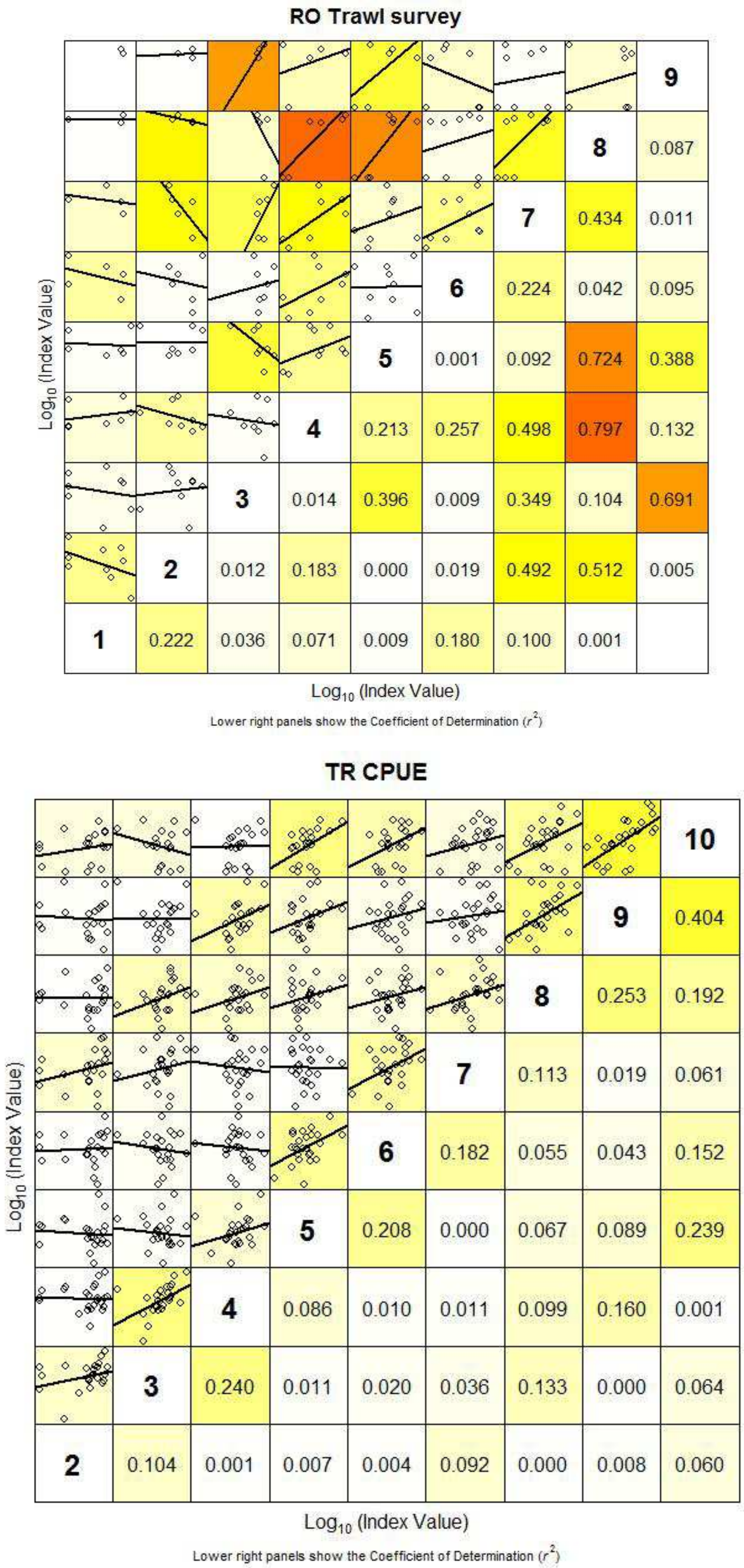


Fig.6.2.4.1.2.1. Fitted linear relationships of cohort trends (i.e. internal consistency) within the five tuning series used in the analysis.

SAM input data (Table. 6.2.4.1.2.2 - Table. 6.2.4.1.2.8).

Table 6.2.4.1.2.2 Turbot in the Black Sea 1950-2012. Total catches including estimated IUU catches.

Year	Catch	Year	Catch	Year	Catch
1950	3932	**1971**	3052	**1992**	439
1951	4741	**1972**	3049	**1993**	1603
1952	5217	**1973**	3705	**1994**	2144
1953	4985	**1974**	1696	**1995**	2943
1954	4505	**1975**	1273	**1996**	2048
1955	3678	**1976**	1584	**1997**	1025
1956	3623	**1977**	2012	**1998**	1588
1957	3017	**1978**	2160	**1999**	1953
1958	4289	**1979**	5447	**2000**	2789
1959	4653	**1980**	2843	**2001**	2557
1960	2680	**1981**	3276	**2002**	1412
1961	3058	**1982**	4662	**2003**	943
1962	2904	**1983**	5307	**2004**	989
1963	3812	**1984**	2852	**2005**	2039
1964	3666	**1985**	527	**2006**	2737
1965	3063	**1986**	428	**2007**	2692
1966	3093	**1987**	849	**2008**	1901
1967	2709	**1988**	1116	**2009**	1541
1968	2931	**1989**	1460	**2010**	1321
1969	3076	**1990**	1393	**2011**	887
1970	5273	**1991**	935	**2012**	963

Table 6.2.4.1.2.3. Catch-at-age data (nbs, 10^3)including estimated IUU catches.

TABLE Black Sea turbot. CATCH IN NUMBER
Units : thousands

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958
2	16.397	19.748	23.692	25.119	21.002	18.31	18.04	14.862	21.169
3	112.918	135.972	164.901	176.873	146.621	128.763	126.874	130.048	259.27
4	216.681	260.864	321.152	349.953	286.75	254.327	250.607	293.781	383.447
5	280.36	337.472	420.244	463.324	376.404	336.296	331.387	387.218	486.748
6	226.152	272.659	302.097	291.305	261.462	214.675	211.467	220.132	309.756
7	180.133	217.37	224.295	195.543	189.597	145.942	143.719	77.563	138.655
8	115.062	138.899	138.981	115.318	116.204	86.64	85.307	41.332	57.23
9	41.986	50.659	52.827	46.801	44.818	34.857	34.327	12.084	18.122
10	25.562	30.857	30.872	25.611	25.811	19.242	18.946	6.269	8.541

age/year	1959	1960	1961	1962	1963	1964	1965	1966	1967
2	33.373	27.762	8.915	14.186	43.495	25.964	11.486	21.708	61.68
3	355.666	138.435	131.955	135.825	235.771	372.001	169.355	132.49	251.327
4	567.8	231.44	278.865	281.284	235.009	312.064	320.28	206.362	235.719
5	402.023	205.908	229.911	172.624	262.933	271.244	265.077	267.176	175.771
6	293.197	182.972	209.673	216.155	290.267	227.835	172.629	236.643	192.666
7	157.728	109.8	112.386	121.817	181.621	136.976	112.799	131.96	93.375
8	64.621	58.186	75.748	72.532	94.435	82.583	69.137	70.776	54.007
9	17.733	13.454	20.071	17.249	15.62	18.076	17.422	13.6	13.28

10	11.175	9.369	11.085	5.081	6.805	6.018	9.17	8.142	7.644

age/year	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
2	35.427	30.656	72.647	1.814	1.875	3.4	2.089	0.211	27.663
3	306.856	334.071	353.927	47.933	72.838	47.204	5.576	11.202	86.728
4	319.099	362.644	171.982	434.073	49.816	62.156	8.826	30.674	35.072
5	204.389	262.83	540.574	200.784	202.466	276.994	44.395	145.872	103.805
6	178.719	186.969	310.77	188.526	209.334	237.515	102.688	99.776	93.079
7	113.986	98.328	234.828	142.951	175.418	208.852	101.49	63.921	64.781
8	49.266	40.67	83.85	42.138	72.451	77.682	36.091	19.512	19.124
9	9.798	8.641	38.218	16.895	28.245	34.258	22.168	7.251	12.702
10	4.943	5.437	41.594	15.546	32.019	49.547	39.956	9.98	34.436

age/year	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
2	20.331	22.42	3.575	12.814	18.143	0.064	0.067	0.061	0.055
3	47.836	64.459	148.2	75.89	75.342	115.985	158.094	53.836	0.776
4	22.505	50.179	106.001	41.273	24.159	69.497	98.656	49.529	2.251
5	73.658	195.913	406.363	162.346	75.826	201.974	375.707	45.761	4.347
6	93.499	134.19	331.837	193.383	136.36	171.426	212.477	75.37	8.461
7	89.041	99.558	252.491	147.618	166.726	172.368	192.419	80.754	15.215
8	29.572	30.561	77.947	49.345	91.002	76.879	77.62	66.218	7.22
9	24.734	19.218	51.679	25.463	51.087	70.832	70.771	45.761	12.188
10	64.526	32.096	107.789	52.008	83.458	157.448	150.266	121.131	27.169

age/year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
2	0.056	0.059	0.057	11.804	55.811	70.661	42.675	436.461	122.823
3	0.056	1.185	0.057	33.052	68.144	120.758	29.139	366.249	283.93
4	0.224	8.296	0.226	41.147	104.67	87.588	29.625	150.765	224.63
5	4.938	12.593	19.53	59.359	94.524	60.376	17.215	63.55	204.966
6	5.78	47.704	29.559	68.128	37.011	47.027	13.473	25.902	62.968
7	11.783	13.926	24.457	34.739	29.226	36.382	15.199	14.71	44.668
8	0.225	13.63	38.181	16.863	20.721	8.41	9.901	14.699	39.514
9	2.581	8.593	8.622	15.852	12.93	6.112	2.271	11.461	33.673
10	30.806	42.222	55.599	52.614	35.602	6.112	2.453	3.249	10.323

age/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2	67.184	38.396	0.01	0.01	0.01	110.151	28.426	80.79	20.717
3	47.037	40.687	62.311	8.951	69.841	98.406	42.512	150.474	33.986
4	311.408	130.189	48.751	25.789	114.285	132.503	133.008	111.603	28.565
5	486.222	168.863	43.585	73.551	76.19	107.75	247.27	130.089	54.114
6	246.691	210.143	50.365	176.184	184.125	78.666	322.937	90.565	77.279
7	87.013	97.104	68.768	97.091	146.031	197.593	103.839	64.237	87.386
8	18.741	42.477	32.285	54.775	25.397	110.854	22.142	5.304	15.985
9	2.444	9.999	13.56	11.2	12.698	56.976	2.584	1.153	0.898
10	2.444	0.011	3.229	0.01	6.349	17.343	7.753	1.384	0.539

age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	13.389	49.463	76.733	87.238	68.7	34.407	7.077	157.577	32.724
3	37.052	96.474	141.472	201.205	98.777	102.933	22.693	49.419	53.317
4	46.66	140.665	319.004	453.814	218.685	127.586	78.873	44.427	88.122
5	61.454	108.857	232.529	266.855	177.475	112.002	139.599	57.503	73.802
6	73.88	80.221	131.603	121.593	111.732	76.709	116.846	24.647	25.938
7	58.547	108.083	97.079	57.347	92.296	118.024	65.605	29.976	40.221

8	27.142	74.992	16.128	10.977	32.449	24.2	30.597	34.203	24.721
9	5.232	11.97	20.446	13.169	5.518	3.476	10.253	15.391	12.189
10	0.01	3.855	0.01	1.411	2.436	0.009	2.524	4.605	3.191

Table 6.2.4.1.2.4.Weight-at-age in catch (kg)

TABLE Black Sea turbot. WEIGHTS AT AGE IN THE CATCH

Units : kg

age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	**1959**	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368

10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	1986	1987	1988	1989	1990	1991	1992	1993	1994
2	0.869	0.869	0.869	1	0.73	0.777	0.947	0.893	0.76
3	1.265	1.265	1.265	1.4	1.247	1.153	1.427	1.1	1.07
4	1.765	1.765	1.765	1.8	1.777	1.71	1.997	1.543	1.593
5	2.243	2.243	2.243	2.2	2.16	2.12	2.647	2.087	2.083
6	3.289	3.289	3.289	3.3	3.243	3.03	3.907	2.963	2.597
7	4.377	4.377	4.377	4	3.9	4.257	5.283	4.443	4.2
8	5.667	5.667	5.667	5.3	5.447	5.467	6.3	5.82	5.9
9	7.368	7.368	7.368	6.6	6.5	6.6	8.8	8.34	8.3
10	10.568	10.568	10.568	12.117	12.278	9.537	9.537	9.369	9.473

age/year	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.72	1.083	1.083	1.083	1.083	1.083	1.083	0.852	0.793
3	0.953	1	1	1.3	1.3	1.227	1.3	1.283	1.292
4	1.57	1.6	1.6	1.7	1.7	1.567	1.7	1.938	1.975
5	2.22	2.1	2.1	2.2	2.2	2.223	2.3	2.532	2.4
6	2.993	2.8	2.8	3.1	3.1	2.87	3.1	3.197	3.116
7	4.423	4.3	4.3	4.3	4.3	3.913	4.1	4.117	4.078
8	6	6	6	6	6	5.233	5.7	5.4	5.4
9	8.5	9.5	9.5	7	7	6.62	9.5	6.6	6.6
10	9.5	10	10.5	10.314	9.5	8.321	12.667	10.25	10

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	0.973	0.843	0.999	0.794	0.571	0.66	0.683	0.604	0.594
3	1.429	1.321	1.507	1.4	1.356	1.155	1.188	1.129	1.39
4	1.953	1.938	2.114	1.891	1.791	1.749	1.726	1.658	1.956
5	2.517	2.545	2.68	2.441	2.42	2.423	2.511	2.363	2.64
6	3.183	3.436	3.501	3.119	3.001	3.415	2.622	3.192	3.364
7	4.238	4.388	4.467	4.706	4.015	4.197	3.846	3.708	4.272
8	5.796	5.78	5.828	6.06	4.694	5.192	5.177	4.962	5.645
9	6.8	7.5	7.4	7.5	5.697	6.323	5.999	5.627	6.552
10	9.921	9.842	9.421	9	6.643	7.109	7.575	7	6.894

Table 6.2.4.1.2.5. Weight-at-age in the stock (kg).

TABLE Black Sea turbot. WEIGHTS AT AGE IN THE STOCK
Units : kg

age/year	1950	1951	1952	1953	1954	1955	1956	1957	1958
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	**1959**	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568

age/year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
2	0.869	0.869	0.869	1	0.73	0.777	0.947	0.893	0.76
3	1.265	1.265	1.265	1.4	1.247	1.153	1.427	1.1	1.07
4	1.765	1.765	1.765	1.8	1.777	1.71	1.997	1.543	1.593
5	2.243	2.243	2.243	2.2	2.16	2.12	2.647	2.087	2.083
6	3.289	3.289	3.289	3.3	3.243	3.03	3.907	2.963	2.597
7	4.377	4.377	4.377	4	3.9	4.257	5.283	4.443	4.2
8	5.667	5.667	5.667	5.3	5.447	5.467	6.3	5.82	5.9
9	7.368	7.368	7.368	6.6	6.5	6.6	8.8	8.34	8.3
10	10.568	10.568	10.568	12.117	12.278	9.537	9.537	9.369	9.473

age/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2	0.72	1.083	1.083	1.083	1.083	1.083	1.083	0.852	0.793
3	0.953	1	1	1.3	1.3	1.227	1.3	1.283	1.292
4	1.57	1.6	1.6	1.7	1.7	1.567	1.7	1.938	1.975
5	2.22	2.1	2.1	2.2	2.2	2.223	2.3	2.532	2.4
6	2.993	2.8	2.8	3.1	3.1	2.87	3.1	3.197	3.116
7	4.423	4.3	4.3	4.3	4.3	3.913	4.1	4.117	4.078
8	6	6	6	6	6	5.233	5.7	5.4	5.4
9	8.5	9.5	9.5	7	7	6.62	9.5	6.6	6.6

10	9.5	10	10.5	10.314	9.5	8.321	12.667	10.25	10

age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	0.973	0.843	0.999	0.794	0.571	0.66	0.683	0.604	0.594
3	1.429	1.321	1.507	1.4	1.356	1.155	1.188	1.129	1.39
4	1.953	1.938	2.114	1.891	1.791	1.749	1.726	1.658	1.956
5	2.517	2.545	2.68	2.441	2.42	2.423	2.511	2.363	2.64
6	3.183	3.436	3.501	3.119	3.001	3.415	2.622	3.192	3.364
7	4.238	4.388	4.467	4.706	4.015	4.197	3.846	3.708	4.272
8	5.796	5.78	5.828	6.06	4.694	5.192	5.177	4.962	5.645
9	6.8	7.5	7.4	7.5	5.697	6.323	5.999	5.627	6.552
10	9.921	9.842	9.421	9	6.643	7.109	7.575	7	6.093

Table 6.2.4.1.2.6. Maturity ogive

TABLE Black Sea turbot. PROPORTION MATURE
Units : NA

age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

age/year	**1957**	**1958**	**1959**	**1960**	**1961**	**1962**	**1963**
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

age/year	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

age/year	1971	1972	1973	1974	1975	1976	1977
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

age/year	1978	1979	1980	1981	1982	1983	1984
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

age/year	1985	1986	1987	1988	1989	1990	1991
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

age/year	1992	1993	1994	1995	1996	1997	1998
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

age/year	1999	2000	2001	2002	2003	2004	2005
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1

9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

age/year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	0	0	0	0	0	0	0
3	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667	0.431667
4	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333	0.678333
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1

Table 6.2.4.1.2.7. Natural mortality over ages.

TABLE Black Sea turbot. NATURAL MORTALITY

Units : NA

age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	**1959**	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	1986	1987	1988	1989	1990	1991	1992	1993	1994
2	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
3	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
4	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
5	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
6	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
7	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
8	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
9	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
10	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105

age/year	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.114	0.114	0.114	0.114	0.114	0.146	0.146	0.146	0.146
3	0.11	0.11	0.11	0.11	0.11	0.139	0.139	0.139	0.139
4	0.108	0.108	0.108	0.108	0.108	0.136	0.136	0.136	0.136
5	0.107	0.107	0.107	0.107	0.107	0.134	0.134	0.134	0.134
6	0.106	0.106	0.106	0.106	0.106	0.133	0.133	0.133	0.133
7	0.106	0.106	0.106	0.106	0.106	0.132	0.132	0.132	0.132
8	0.105	0.105	0.105	0.105	0.105	0.131	0.131	0.131	0.131
9	0.105	0.105	0.105	0.105	0.105	0.13	0.13	0.13	0.13
10	0.105	0.105	0.105	0.105	0.105	0.13	0.13	0.13	0.13

age/year	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146
3	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139
4	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136
5	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
6	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
7	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132
8	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
9	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
10	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13

Table 6.2.4.1.2.8. Tuning series.

TABLE		Black	Sea	turbot.	SURVEY	INDICES				
RO	Trawl	survey	-	Configuration						
BLACK	SEA	TURBOT	Total 2013	COMBSEX	TUNING	DATA(effort	nos at age	Imported	from VPA	file

	min	max	plusgroup	minyear	maxyear	startf	endf
	4	9	9	2003	2012	0.45	0.55

Index type : number

RO Trawl survey - Index Values

Units : NA

age \ year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
4	71.57	63.16	113.18	145.08	244.96	228.11	136.44	126.53	173.48	129.46
5	64.24	77.36	79.23	145.09	105.58	101.16	107.2	98.98	138.42	145.06
6	70.08	68.31	24.52	36.69	26.94	35.23	58.24	47.97	68.15	83.71
7	39.42	16.75	16.98	11.02	13.48	14.03	35.74	26.23	37.8	53.55
8	0.01	16.43	21.28	0.01	0.01	0.01	15.23	12.28	32.75	20.07
9	0.01	0.01	0.01	0.01	0.01	0.01	10.12	2.53	6.76	3.77

UKR Trawl survey West - Configuration

BLACK SEA TURBOT Total 2013 COMBSEX TUNING DATA(effort nos at age Imported from VPA file

	min	max	plusgroup	minyear	maxyear	startf	endf
	4	10	10	1989	2007	0.75	0.83

Index type : number

UKR Trawl survey West - Index Values

Units : NA

age \ year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
4	24.77	13.12	41.04	37.77	29.37	28.2	NA	NA	NA	19.36
5	35.74	13.83	29.7	33.15	53.37	51.25	NA	NA	NA	55.5
6	41.02	18.13	28.8	38.03	34.73	33.35	NA	NA	NA	122.93
7	20.92	19.68	21.6	28.01	33.2	31.88	NA	NA	NA	70.34
8	10.15	11.69	4.68	6.42	29.37	28.2	NA	NA	NA	37.11
9	9.54	8.71	4.14	5.4	25.03	24.03	NA	NA	NA	10.97
10	8.94	5.84	0.9	1.03	5.62	5.4	NA	NA	NA	0.01

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007
4	NA	NA	60.94	50.2	23.53	45.97	20.99	176.46	153.74
5	NA	NA	77.7	89.77	60.51	60.23	45.17	114.86	121.44
6	NA	NA	22.85	64.96	95.99	89.02	49.18	71.32	56.85
7	NA	NA	4.57	53.15	139.68	104.56	95.17	50.48	39.62
8	NA	NA	0.65	6.79	33.24	40.84	70.17	7.87	9.04
9	NA	NA	0.65	1.48	1.87	12.85	13.61	10.19	12.06
10	NA	NA	0.65	0.89	1.12	0.01	3.23	0.01	1.29

BG Trawl survey - Configuration

BLACK SEA TURBOT Total 2013 COMBSEX TUNING DATA(effort nos at age Imported from VPA file .

	min	max	plusgroup	minyear	maxyear	startf	endf
	2	7	NA	2006	2012	0.5	0.5

Index type : number

BG Trawl survey - Index Values

Units : NA

age	year 2006	2007	2008	2009	2010	2011	2012
2	222.36	124.13	171.01	19.95	5.1	38.33	9.85
3	259.03	233.08	118.97	139.66	7.66	38.33	19.71
4	108.82	328.24	215.63	136.59	24.24	26.35	26.28
5	41.4	204.12	270.15	155.01	57.42	16.77	13.14
6	24.84	86.89	161.1	102.83	37	26.35	9.85
7	10.65	13.79	19.83	30.7	17.86	21.56	6.57

TR CPUE - Configuration

BLACK SEA TURBOT Total 2013 COMBSEX TUNING DATA(effort nos at age Imported from VPA file .

min	max	plusgroup	minyear	maxyear	startf	endf
2	10	10	1987	2012	0.45	0.55

Index type : number

TR CPUE - Index Values

Units : NA

age	year 1987	1988	1989	1990	1991	1992	1993	1994
2	0.92	1.13	138.23	342.49	649.47	223.13	648.31	922.43
3	18.53	1.13	387.05	418.17	1109.94	152.35	544.02	2132.38
4	129.7	4.54	481.83	642.33	805.06	154.9	223.94	1687.02
5	196.87	391.07	695.1	580.06	554.94	90.01	94.4	1539.34
6	745.77	591.9	797.79	227.12	432.24	70.45	38.47	472.9
7	217.71	489.73	406.79	179.35	334.4	79.47	21.85	335.47
8	213.08	764.53	197.47	127.16	77.3	51.77	21.83	296.76
9	134.33	172.64	185.62	79.35	56.18	11.87	17.02	252.89
10	660.07	1113.31	616.11	218.48	56.18	12.82	4.83	77.53

age	year 1995	1996	1997	1998	1999	2000	2001	2002	2003
2	516.78	78.02	0.02	0.03	0.02	383.21	38.6	50.26	45.01
3	361.81	82.68	139.88	30.41	133.81	342.35	57.72	97.46	78.46
4	2395.37	264.56	109.44	87.61	218.96	460.97	180.6	73.81	73.14
5	3740.04	343.15	97.85	249.87	145.97	374.86	335.75	86.93	122.41
6	1897.56	427.03	113.07	598.53	352.77	273.67	438.5	60.6	173.12
7	669.31	197.33	154.38	329.84	279.78	687.42	141	43.06	185.6
8	144.16	86.32	72.48	186.08	48.66	385.66	30.07	3.56	31.04
9	18.8	20.32	30.44	38.05	24.33	198.22	3.51	0.77	1.74
10	18.8	0.02	7.25	0.03	12.16	60.33	10.53	0.93	1.05

age	year 2004	2005	2006	2007	2008	2009	2010	2011	2012
2	34.73	95.16	192.51	174.81	96.98	60.94	10.74	64.23	19.91
3	88.41	285.55	257.46	328.31	104.71	162.82	34.42	20.14	32.45
4	108.86	292.43	348.84	623.2	234.67	182.62	119.65	18.11	53.63
5	133.97	203.79	257.39	299.92	148.35	118.27	211.77	23.44	44.91
6	148.39	97.92	157.26	153.74	99.48	68.3	177.26	10.05	15.78
7	101.34	80.79	134.77	55.12	52.21	85.19	99.52	12.22	24.48
8	54.85	53.54	25.72	7.24	18.05	13.97	46.42	13.94	15.04
9	6.16	4.66	33.37	7.06	3	2.01	15.55	6.27	7.42

10	0.05	1.5	0.04	0.76	1.15	0.02	3.83	1.88	1.94

UKR Trawl survey East - Configuration

BLACK SEA TURBOT Total 2013 COMBSEX TUNING DATA(effort nos at age Imported from VPA file .

min	max	plusgroup	minyear	maxyear	startf	endf
2	10	10	1989	2006	0.75	0.83

Index type : number

UKR Trawl survey East - Index Values

Units : NA

age \ year	1989	1990	1991	1992	1993	1994	1995	1996	1997
2	2.22	0.94	6.01	11.43	4.45	7.06	NA	NA	NA
3	6.21	1.69	2.8	14.95	8.74	13.87	NA	NA	NA
4	7.73	4.32	10.42	11.75	9.31	14.77	NA	NA	NA
5	11.15	4.55	13.21	10.31	16.92	26.85	NA	NA	NA
6	12.8	5.97	12.56	11.83	11.01	17.47	NA	NA	NA
7	6.53	6.48	6.96	8.71	10.53	16.7	NA	NA	NA
8	3.17	3.85	1.73	2	9.31	14.77	NA	NA	NA
9	2.98	2.87	1.79	1.68	7.93	12.59	NA	NA	NA
10	2.79	1.92	0.36	0.32	1.78	2.83	NA	NA	NA

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	0.01	NA	NA	0.01	0.01	0.25	0.75	0.46	0.21
3	0.44	NA	NA	0.36	0.74	0.48	3.38	0.46	0.34
4	1.12	NA	NA	1.45	1.38	0.98	5.8	2.09	1.33
5	3.13	NA	NA	1.09	2.46	2.52	4.69	1.62	1.19
6	9.38	NA	NA	2.91	1.78	4	4.36	1.39	0.75
7	4.68	NA	NA	2.55	1.46	5.82	3.82	0.23	0.75
8	3.13	NA	NA	0.73	0.19	1.39	2.99	0.01	0.13
9	0.01	NA	NA	0.01	0.04	0.08	0.01	0.01	0.2
10	0.01	NA	NA	0.01	0.02	0.05	0.01	0.01	0.01

6.2.4.1.3*Results*

STECF EWG 13-12 evaluatedthe Black Sea Turbotstock applying the state-space assessment model (SAM) (Nielsen et al., 2012). Version details and model configuration are listed below and are similar to those, used for the assessment for the period 1950 - 2011. In the new assessment, two additional tuning data sets were used (i.e. Romanian survey and Ukranian East survey).

Black Sea turbot. STOCK OBJECT CONFIGURATION

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
2	10	10	1950	2012	4	8

Black Sea turbot. sam CONFIGURATION SETTINGS

name : Final Assessment

```
desc           :
range          :      min      max plusgroup   minyear   maxyear   minfbar   maxfbar
range          :        2       10        10      1950      2012         4         8
fleets         :              catch       RO Trawl survey UKR Trawl survey West
fleets         :                  0                     2                     2
fleets         :      BG Trawl survey              TR CPUE UKR Trawl survey East
fleets         :                  2                     2                     2
plus.group     : TRUE
states         :                       age
states         : fleet                  2  3  4  5  6  7  8  9 10
states         :   catch                1  2  3  4  5  6  7  7  7
states         :   RO Trawl survey      NA NA NA NA NA NA NA NA NA
states         :   UKR Trawl survey West NA NA NA NA NA NA NA NA NA
states         :   BG Trawl survey      NA NA NA NA NA NA NA NA NA
states         :   TR CPUE              NA NA NA NA NA NA NA NA NA
states         :   UKR Trawl survey East NA NA NA NA NA NA NA NA NA
logN.vars      : 1 2 2 2 2 2 2 2 2
catchabilities :                       age
catchabilities : fleet                  2  3  4  5  6  7  8  9 10
catchabilities :   catch                NA NA NA NA NA NA NA NA NA
catchabilities :   RO Trawl survey      NA NA 29 29 29 29 30 31 NA
catchabilities :   UKR Trawl survey West NA NA  3  4  5  6  7  8  9
catchabilities :   BG Trawl survey      17 18 19 20 21 21 NA NA NA
catchabilities :   TR CPUE               1 22 23 24 25 26 27 28  2
catchabilities :   UKR Trawl survey East 10 11 12 13 14 15 15 15 16
power.law.exps :                       age
power.law.exps : fleet                  2  3  4  5  6  7  8  9 10
power.law.exps :   catch                NA NA NA NA NA NA NA NA NA
power.law.exps :   RO Trawl survey      NA NA NA NA NA NA NA NA NA
power.law.exps :   UKR Trawl survey West NA NA NA NA NA NA NA NA NA
power.law.exps :   BG Trawl survey      NA NA NA NA NA NA NA NA NA
power.law.exps :   TR CPUE              NA NA NA NA NA NA NA NA NA
power.law.exps :   UKR Trawl survey East NA NA NA NA NA NA NA NA NA
f.vars         :                       age
f.vars         : fleet                  2  3  4  5  6  7  8  9 10
f.vars         :   catch                1  2  2  2  2  2  2  2  2
f.vars         :   RO Trawl survey      NA NA NA NA NA NA NA NA NA
f.vars         :   UKR Trawl survey West NA NA NA NA NA NA NA NA NA
f.vars         :   BG Trawl survey      NA NA NA NA NA NA NA NA NA
f.vars         :   TR CPUE              NA NA NA NA NA NA NA NA NA
f.vars         :   UKR Trawl survey East NA NA NA NA NA NA NA NA NA
obs.vars       :                       age
obs.vars       : fleet                  2  3  4  5  6  7  8  9 10
obs.vars       :   catch                1  2  3  4  5  6  7  7  8
obs.vars       :   RO Trawl survey      NA NA  9  9 10 10 11 12 NA
obs.vars       :   UKR Trawl survey West NA NA 13 14 14 15 16 17 18
obs.vars       :   BG Trawl survey      26 27 28 29 30 31 NA NA NA
obs.vars       :   TR CPUE              32 33 34 35 36 37 37 37 38
obs.vars       :   UKR Trawl survey East 19 20 21 22 22 22 23 24 25
srr            : 0
cor.F          : FALSE
nohess         : FALSE
timeout        : 3600
```

Black Sea turbot. FLR, R SOFTWARE VERSIONS

FLSAM.version	0.99-9
FLCore.version	2.5.0
R.version	R version 2.15.0 (2012-03-30)
platform	i386-pc-mingw32
run.date	2013-10-01 15:26:10

SAM outputs and model diagnostics are listed in the Table6.2.4.1.3.1.

Table6.2.4.1.3.1. Summary table of the final SAM model and model diagnostics.

TABLE Black Sea turbot. STOCK SUMMARY

Year	Rec	Low	High	TSB	Low	High	SSB	Low	High	Fbar (4-8)	Low	High	Landi ngs	Landing sSOP
1950	1972	1330	2924	16768	13843	20310	9965	8120	12229	0.4774	0.346	0.6589	3932	1
1951	1903	1325	2732	16521	13897	19641	9737	8045	11785	0.5194	0.3954	0.6821	4741	1.0001
1952	1744	1210	2513	15640	13146	18607	9053	7491	10942	0.5716	0.443	0.7375	5217	1
1953	1905	1339	2709	14501	12165	17287	8066	6675	9746	0.6087	0.4766	0.7774	4985	1.0001
1954	2049	1445	2905	13514	11330	16119	7121	5905	8587	0.6577	0.5184	0.8344	4505	1.0001
1955	1982	1387	2832	12718	10635	15210	6495	5405	7805	0.6882	0.5455	0.8683	3678	1
1956	1878	1312	2687	12204	10164	14652	6217	5170	7475	0.7308	0.5716	0.9343	3623	1
1957	1858	1304	2649	11911	9898	14333	6300	5241	7573	0.6318	0.4936	0.8087	3017	1.0002
1958	1916	1356	2707	12039	10054	14416	6257	5227	7489	0.6838	0.5433	0.8606	4289	0.9999
1959	1776	1253	2515	11697	9813	13943	6019	5048	7175	0.7149	0.5637	0.9067	4653	0.9999
1960	1685	1184	2397	11184	9393	13315	5944	4989	7082	0.6426	0.5039	0.8193	2680	0.9999
1961	1636	1148	2333	11082	9327	13167	6010	5047	7156	0.6458	0.5057	0.8248	3058	1.0001
1962	1620	1130	2322	11034	9291	13103	6014	5049	7163	0.6451	0.5044	0.8251	2904	0.9999
1963	1730	1217	2459	11026	9279	13102	5772	4844	6876	0.7011	0.5538	0.8874	3812	1.0001
1964	1632	1153	2311	10595	8902	12609	5486	4602	6540	0.7053	0.5558	0.8951	3666	1
1965	1909	1361	2677	10504	8830	12495	5333	4461	6376	0.6862	0.5356	0.8791	3063	0.9999
1966	1980	1411	2780	10776	9060	12818	5414	4512	6496	0.6886	0.5267	0.9003	3093	1.0001
1967	2031	1446	2855	11238	9413	13418	5815	4812	7027	0.5973	0.439	0.8126	2709	1
1968	1739	1238	2443	11763	9809	14106	6548	5362	7996	0.5084	0.3664	0.7055	2931	1
1969	1386	979	1960	12091	10007	14609	7265	5858	9010	0.4368	0.3167	0.6025	3076	0.9999
1970	1043	736	1478	11997	9800	14685	7374	5777	9412	0.5088	0.3627	0.7137	5273	1
1971	842	594	1195	10881	8664	13665	7125	5349	9489	0.4201	0.293	0.6024	3052	1
1972	909	648	1277	10258	7889	13338	6682	4715	9468	0.4272	0.2899	0.6294	3049	1.0001
1973	994	714	1382	9598	7064	13041	6041	3920	9309	0.4597	0.2948	0.7168	3705	1.0001
1974	1333	963	1845	9225	6532	13028	5846	3578	9551	0.3372	0.2056	0.5531	1696	1.0001
1975	1506	1093	2076	10026	7075	14206	6456	3955	10536	0.2587	0.1602	0.4177	1273	1.0001
1976	1636	1189	2253	11539	8299	16044	7530	4777	11870	0.2307	0.1464	0.3636	1584	1
1977	1461	1067	2000	13061	9584	17800	8833	5856	13324	0.2312	0.1509	0.3543	2012	1.0001
1978	1230	888	1704	14256	10624	19129	10020	6883	14585	0.2447	0.1664	0.3597	2160	1.0001
1979	798	557	1144	14726	11006	19704	10461	7321	14948	0.3209	0.2276	0.4525	5447	1.0001
1980	445	295	672	13643	10134	18368	10279	7193	14690	0.277	0.1973	0.3889	2843	1.0001
1981	285	200	405	12564	9125	17299	9676	6641	14097	0.2909	0.2101	0.4028	3276	1
1982	216	155	300	11030	7743	15713	8381	5520	12723	0.3617	0.27	0.4845	4662	1
1983	218	162	295	8920	5958	13354	6542	4022	10642	0.4958	0.3568	0.6891	5307	1
1984	210	157	280	6635	4128	10663	5049	2858	8920	0.4474	0.3042	0.6579	2852	1
1985	221	166	296	5347	3157	9055	4398	2399	8063	0.2227	0.1417	0.35	527	1
1986	245	184	326	5059	3017	8485	4251	2359	7662	0.1398	0.0859	0.2275	428	1.0001
1987	277	206	372	5020	3113	8093	3913	2266	6757	0.195	0.1402	0.2711	849	1.0001
1988	326	238	446	4577	3017	6943	3226	2002	5198	0.2848	0.217	0.3737	1116	1.0001
1989	463	341	629	4289	3048	6034	2589	1725	3887	0.4292	0.3309	0.5567	1460	0.9987
1990	722	535	974	3666	2858	4704	1979	1465	2673	0.5228	0.4049	0.6751	1393	0.9935
1991	1102	807	1505	3710	3114	4420	1767	1450	2153	0.5071	0.3839	0.6699	935	0.9774
1992	1354	969	1893	5511	4633	6556	2667	2259	3149	0.3485	0.2559	0.4745	439	0.9691
1993	1341	945	1904	5769	4820	6904	2906	2450	3447	0.3583	0.2702	0.4752	1603	0.943
1994	1123	824	1531	6304	5307	7488	3432	2880	4090	0.5772	0.4533	0.7348	2144	0.9998
1995	903	667	1223	6551	5570	7705	3750	3161	4449	0.7108	0.5559	0.9088	2943	0.9994

1996	646	472	883	6235	5371	7238	3498	2968	4124	0.7449	0.5935	0.9349	2048	0.9771
1997	657	473	912	5768	4992	6666	3380	2889	3954	0.6587	0.517	0.8393	1025	1
1998	771	568	1048	6132	5307	7086	3532	3006	4150	0.5773	0.4516	0.7381	1588	1.0001
1999	765	570	1027	6058	5200	7058	3279	2723	3948	0.6111	0.4823	0.7743	1953	1
2000	729	544	978	5408	4587	6377	2523	2122	2999	1.0395	0.8579	1.2595	2789	0.9995
2001	632	472	847	4840	4150	5646	2357	2018	2753	1.2456	1.0446	1.4852	2557	0.9999
2002	709	526	956	4510	3896	5221	2521	2168	2933	0.7595	0.6183	0.933	1412	1
2003	936	696	1259	4587	3962	5309	2495	2141	2907	0.6221	0.4994	0.775	943	0.9983
2004	1262	926	1719	5603	4779	6570	2715	2304	3199	0.618	0.4853	0.787	989	0.999
2005	1309	930	1841	6240	5244	7426	2910	2464	3436	0.8049	0.6645	0.975	2039	0.9955
2006	1133	793	1619	7198	5964	8686	3446	2906	4087	0.8608	0.715	1.0363	2737	0.9964
2007	840	584	1207	6420	5298	7780	3418	2869	4072	0.809	0.6658	0.9829	2692	0.9984
2008	590	397	876	5414	4474	6553	3027	2540	3607	0.9082	0.7437	1.1091	1901	0.9995
2009	422	262	681	4466	3721	5359	2512	2109	2991	0.7879	0.643	0.9655	1541	1.0001
2010	358	210	610	3216	2593	3988	1736	1412	2135	0.7904	0.6366	0.9813	1321	0.9963
2011	353	186	667	2398	1795	3204	1300	956	1769	0.732	0.5552	0.9651	887	0.9458
2012	325	144	733	2172	1427	3307	1121	680	1849	0.8546	0.567	1.288	963	0.9982

TABLE Black Sea turbot. ESTIMATED FISHING MORTALITY

Units : f

age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**
2	0.0091922	0.011087	0.013965	0.01349549	0.01104	0.01002674
3	0.08875283	0.092025	0.0967427	0.10151994	0.10046	0.09998851
4	0.2020379	0.212099	0.2302706	0.24820506	0.263237	0.25059931
5	0.33895091	0.37431	0.4312445	0.49642642	0.524259	0.56707143
6	0.40829309	0.448301	0.5097015	0.5613167	0.62474	0.64695405
7	0.57337232	0.642505	0.7059365	0.72956267	0.791299	0.84966766
8	0.86458989	0.9196	0.9807987	1.00805346	1.084759	1.12674168
9	0.86458989	0.9196	0.9807987	1.00805346	1.084759	1.12674168
10	0.86458989	0.9196	0.9807987	1.00805346	1.084759	1.12674168

age/year	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**
2	0.01005686	0.00923	0.0119802	0.01781882	0.015415	0.00738134
3	0.10405871	0.111637	0.1215414	0.12643841	0.126755	0.12904424
4	0.24556343	0.26416	0.2927899	0.30746316	0.281478	0.28462009
5	0.50486713	0.481933	0.5155144	0.49275657	0.399656	0.3481228
6	0.74547029	0.662755	0.6712457	0.70941826	0.635731	0.59392039
7	0.88521918	0.706127	0.8579839	0.87606937	0.73518	0.7260619
8	1.27287739	1.044113	1.0815519	1.18888988	1.160731	1.27647197
9	1.27287739	1.044113	1.0815519	1.18888988	1.160731	1.27647197
10	1.27287739	1.044113	1.0815519	1.18888988	1.160731	1.27647197

age/year	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**
2	0.01024875	0.020961	0.0160043	0.00813565	0.012462	0.02566826
3	0.13357395	0.14182	0.1437614	0.1400158	0.129044	0.12816971
4	0.28596095	0.28238	0.2881425	0.27223217	0.257226	0.22400207
5	0.34369522	0.390011	0.4135901	0.42671455	0.39005	0.35565291
6	0.55609841	0.645952	0.6654379	0.6272626	0.693503	0.58108978
7	0.72935843	0.876464	0.8593319	0.81702139	0.890796	0.75075193
8	1.31052786	1.310515	1.3000465	1.28770299	1.211586	1.07495199
9	1.31052786	1.310515	1.3000465	1.28770299	1.211586	1.07495199

10	1.31052786	1.310515	1.3000465	1.28770299	1.211586	1.07495199

age/year	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**
2	0.02263178	0.025337	0.0405914	0.00365704	0.002486	0.00297533
3	0.12488025	0.120826	0.1107256	0.09222722	0.078402	0.0622747
4	0.21250282	0.193225	0.1705716	0.15386187	0.112152	0.08538371
5	0.31512055	0.344039	0.3824375	0.33979934	0.350779	0.34593652
6	0.53866038	0.445058	0.5062827	0.46000864	0.473554	0.53723482
7	0.65598983	0.61202	0.8217739	0.64302608	0.712582	0.87679681
8	0.81995977	0.589577	0.6626953	0.50402974	0.486699	0.45327784
9	0.81995977	0.589577	0.6626953	0.50402974	0.486699	0.45327784
10	0.81995977	0.589577	0.6626953	0.50402974	0.486699	0.45327784

age/year	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
2	0.00145638	0.000407	0.0094221	0.01381915	0.015408	0.00735482
3	0.04937555	0.046454	0.0514266	0.05603941	0.064726	0.07651259
4	0.05943334	0.053009	0.0480795	0.04663985	0.052418	0.06166739
5	0.24166568	0.227183	0.1967345	0.1659946	0.200829	0.24504829
6	0.44879458	0.373637	0.3030674	0.2765676	0.26498	0.34020735
7	0.60274564	0.425049	0.3930966	0.40728993	0.432726	0.59536537
8	0.33353749	0.214574	0.2124816	0.25973329	0.272368	0.36222127
9	0.33353749	0.214574	0.2124816	0.25973329	0.272368	0.36222127
10	0.33353749	0.214574	0.2124816	0.25973329	0.272368	0.36222127

age/year	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
2	0.02505956	0.029449	0.0006548	0.00035943	0.000309	0.00026704
3	0.08766785	0.100812	0.1041732	0.08693453	0.055365	0.0300979
4	0.06651685	0.077514	0.1019676	0.11042707	0.083542	0.04664918
5	0.2350399	0.240557	0.3977666	0.6719509	0.381734	0.15446311
6	0.32507479	0.319308	0.381849	0.59891236	0.715195	0.29558466
7	0.43837525	0.459645	0.5473921	0.71874403	0.745127	0.45438065
8	0.31969112	0.357471	0.3796749	0.37917024	0.311206	0.16261009
9	0.31969112	0.357471	0.3796749	0.37917024	0.311206	0.16261009
10	0.31969112	0.357471	0.3796749	0.37917024	0.311206	0.16261009

age/year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
2	0.00024683	0.000249	0.0003908	0.01614411	0.061754	0.05932052
3	0.01957113	0.01897	0.0206157	0.03442749	0.050328	0.0634058
4	0.03168538	0.036196	0.0393799	0.07804263	0.137175	0.1748372
5	0.10752843	0.124855	0.1719073	0.25952558	0.384854	0.44828773
6	0.20357923	0.299572	0.343386	0.48133586	0.41316	0.40849729
7	0.25789571	0.251855	0.4016155	0.61707173	0.746761	0.62475232
8	0.0983424	0.262265	0.4675168	0.71007832	0.932109	0.87931683
9	0.0983424	0.262265	0.4675168	0.71007832	0.932109	0.87931683
10	0.0983424	0.262265	0.4675168	0.71007832	0.932109	0.87931683

age/year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
2	0.0456341	0.193864	0.118091	0.06742091	0.022429	5.2155E-05
3	0.06989928	0.084214	0.0905277	0.08558887	0.083526	0.08559743
4	0.17440066	0.191111	0.2153695	0.23433584	0.200468	0.16836854
5	0.32556277	0.324296	0.3720154	0.45644823	0.369395	0.22736469
6	0.34126363	0.321101	0.3871473	0.54571414	0.625165	0.4336099
7	0.32624717	0.327326	0.5549263	0.76391405	0.729519	0.59548445

8	0.57486503	0.627884	1.3563266	1.55353037	1.799772	1.86876914
9	0.57486503	0.627884	1.3563266	1.55353037	1.799772	1.86876914
10	0.57486503	0.627884	1.3563266	1.55353037	1.799772	1.86876914

age/year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
2	2.0791E-05	5.14E-05	0.0395535	0.05905418	0.100651	0.02817839
3	0.07829277	8.45E-02	0.0936023	0.10212068	0.113438	0.10852226
4	0.16674326	1.71E-01	0.1734614	0.18007173	0.182629	0.17622389
5	0.22031433	2.69E-01	0.3020689	0.34493475	0.307709	0.26163628
6	0.45690033	4.76E-01	0.5984095	0.78351114	0.522046	0.43648119
7	0.74596992	1.17E+00	2.0301913	2.56443966	1.245304	0.97038634
8	1.29669666	9.69E-01	2.0933172	2.35504539	1.539935	1.26595908
9	1.29669666	9.69E-01	2.0933172	2.35504539	1.539935	1.26595908
10	1.29669666	9.69E-01	2.0933172	2.35504539	1.539935	1.26595908

age/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2	0.01540289	0.036619	0.0673805	0.1079702	0.130498	0.09466604
3	0.1058005	0.110881	0.1251303	0.1442078	0.158659	0.17154666
4	0.18738312	0.215262	0.2511512	0.3232595	0.370145	0.38537823
5	0.28416506	0.348994	0.4036044	0.4505258	0.593897	0.65612104
6	0.40710669	0.478681	0.5775328	0.5415445	0.497659	0.58858731
7	0.69453689	1.285002	1.6284522	1.1150174	1.153995	1.05856159
8	1.51694736	1.696725	1.443167	1.6144914	1.925508	1.25090839
9	1.51694736	1.696725	1.443167	1.6144914	1.925508	1.25090839
10	1.51694736	1.696725	1.443167	1.6144914	1.925508	1.25090839

age/year	**2010**	**2011**	**2012**
2	0.04169392	0.292468	0.1444676
3	0.1665766	0.172717	0.1810286
4	0.3850046	0.341332	0.3523607
5	0.76046134	0.675501	0.6415681
6	0.68516198	0.504736	0.4694094
7	0.85861041	0.661934	1.0254771
8	1.26267186	1.476494	1.7841819
9	1.26267186	1.476494	1.7841819
10	1.26267186	1.476494	1.7841819

TABLE Black Sea turbot. ESTIMATED POPULATION ABUNDANCE

Units : NA

age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**
2	1971.993	1902.835	1743.936	1904.7385	2048.5756	1981.878	1877.507
3	2018.884	1745.681	1681.935	1525.5343	1677.3996	1814.019	1751.977
4	1622.138	1656.066	1428.385	1369.9096	1226.9663	1359.674	1476.161
5	1231.638	1190.585	1203.513	1019.4311	960.25608	841.0911	950.7014
6	792.6645	789.6581	736.5669	703.03031	557.29794	511.22	426.0258
7	442.2609	474.5657	454.2738	398.05891	360.89967	268.0303	241.1936
8	220.3462	224.5279	224.6177	201.68357	172.72487	147.1423	102.9867
9	76.70754	83.60472	80.65655	75.84562	66.30067	52.5676	42.9785
10	48.92067	47.65083	47.1154	43.13782	39.0913	32.06612	24.69251

age/year	1957	1958	1959	1960	1961	1962	1963
2	1858.454	1915.627	1775.611	1684.9649	1636.4753	1619.868	1730.386
3	1655.9	1641.392	1694.766	1554.4857	1478.6725	1449.683	1427.529
4	1416.012	1325.308	1299.975	1341.3073	1225.8626	1163.398	1136.945
5	1041.17	977.3062	886.2508	855.25528	911.68998	827.2443	783.9145
6	516.3062	580.2157	524.0568	484.97629	514.70813	580.7382	527.8964
7	180.7292	239.9187	267.4413	231.34266	230.71888	255.4432	301.0872
8	89.31773	80.39886	91.40498	100.063	99.833121	100.3636	110.9966
9	25.89889	28.31807	24.56936	25.02562	28.221949	25.07823	24.35166
10	17.05085	13.61402	12.8071	10.2533	9.954254	9.587882	8.419075

age/year	1964	1965	1966	1967	1968	1969	1970
2	1632.226	1908.934	1980.491	2031.4396	1739.2339	1385.616	1043.045
3	1516.864	1422.968	1697.31	1746.3794	1775.7888	1520.965	1207.974
4	1106.879	1179.446	1100.368	1343.5894	1376.5009	1410.219	1209.062
5	770.1613	742.483	807.7883	758.54339	969.32505	998.5458	1046.807
6	476.1343	457.6936	433.8071	491.91208	475.13549	640.0844	636.0009
7	248.7131	219.7301	220.3242	194.00812	247.91848	248.2658	372.1883
8	112.708	94.6608	87.36546	81.150057	82.195454	115.92	121.3404
9	26.95315	27.63823	23.48824	23.396817	24.873426	32.4922	58.08457
10	7.958177	8.571134	8.998879	8.711117	9.867041	13.7825	23.14318

age/year	1971	1972	1973	1974	1975	1976	1977
2	842.3537	909.2317	993.5655	1332.7503	1505.8307	1636.312	1461.034
3	889.8029	743.0029	809.3245	877.43247	1193.5651	1349.244	1452.44
4	969.0343	724.2959	610.2081	681.23001	745.08626	1028.545	1152.743
5	916.3515	743.4489	579.6938	498.34868	578.53555	631.9435	887.315
6	640.9811	588.043	469.0456	366.09761	350.68907	415.0089	464.8431
7	343.745	364.3446	330.4978	245.15729	209.28564	216.5887	276.58
8	146.8483	162.9755	160.9832	123.05113	120.33746	123.1743	131.486
9	56.22716	79.88595	90.27856	92.00105	78.89359	87.27814	89.87322
10	37.71659	51.14169	72.57351	93.21419	119.42637	144.2142	168.6963

age/year	1978	1979	1980	1981	1982	1983	1984
2	1230.161	798.3922	445.4567	284.519	215.5515	218.4375	209.5998
3	1287.812	1089.201	711.6598	385.6383	244.4474	190.8523	195.2538
4	1236.45	1083.444	909.9594	587.4552	310.3808	195.1757	155.0271
5	993.8636	1059.021	914.795	769.9303	491.617	249.3855	154.4546
6	683.9604	734.4339	745.3098	650.6032	551.091	298.3598	112.4041
7	316.461	478.6645	469.8906	484.7339	426.8361	342.681	147.3484
8	165.9522	185.1007	237.3415	273.8553	275.9722	222.8502	150.7315
9	91.27711	114.2855	115.8852	155.5084	173.0188	170.4769	137.6205
10	179.6481	186.0099	188.3685	199.2181	223.7211	244.5696	255.7755

age/year	1985	1986	1987	1988	1989	1990	1991
2	221.2957	244.9857	277.0229	326.03346	462.8486	722.0541	1102.13
3	186.3823	197.0978	218.4157	247.05229	289.91854	403.792	604.8013
4	165.389	162.0168	174.06	192.51999	219.6642	248.2906	340.0525
5	126.1157	142.0672	142.124	151.16924	169.27083	182.7465	191.0433
6	93.29812	96.67937	115.862	113.7269	114.53724	117.8014	112.2244
7	48.39033	62.19036	71.52164	77.32366	73.04678	62.58965	70.81706
8	62.49584	27.22675	43.44084	50.6227	46.40931	35.43854	26.31923

9	99.25576	47.59844	22.36954	30.08119	28.56265	20.53642	12.53469
10	259.2519	274.1567	262.2505	196.8811	127.71484	68.99265	31.61084

age/year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
2	1354.381	1341.441	1123.383	903.06994	645.93572	657.0105	771.4717
3	931.0379	1161.886	987.622	889.9809	755.0621	555.0732	586.9267
4	504.6676	780.8632	958.1458	803.11667	730.99016	624.7803	449.2143
5	250.6105	378.0778	583.4157	694.71383	563.40572	536.4106	477.5649
6	106.9969	161.112	245.4517	364.855	392.05416	345.6753	387.4939
7	66.81984	66.967	105.267	151.24484	190.20454	186.5874	201.4216
8	34.05238	43.71975	43.21553	54.22272	63.206048	82.37648	92.54546
9	9.760074	17.3484	21.28282	9.877901	10.35221	9.394271	11.50981
10	16.48251	13.34444	14.8144	8.333637	3.435629	2.052339	1.572631

age/year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
2	764.942	729.4567	632.1331	709.10244	936.26635	1261.681	1308.583
3	695.6871	687.6638	604.5594	511.68029	551.58723	786.7417	1083.986
4	489.8994	578.6513	547.904	475.61086	394.65028	429.7914	616.834
5	339.3731	373.0827	427.9473	401.25615	346.57526	290.0925	311.6872
6	350.6189	232.1306	242.2088	265.70854	258.37189	235.7802	191.4832
7	221.0303	198.6213	111.4415	97.212568	139.1427	145.9261	138.1445
8	86.31471	61.68865	22.79178	7.4872382	24.64564	45.9889	64.7284
9	22.79406	29.90124	6.59888	1.8938087	1.402968	6.114726	8.793387
10	3.229412	8.920036	4.21142	0.9048012	0.5290936	0.475751	1.271542

age/year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	1133.426	839.6625	589.6328	422.41997	358.2747	352.6232	324.9593
3	1096.195	918.0942	651.0588	445.3676	330.53085	297.3471	227.1476
4	854.1442	846.7454	690.9034	482.84708	323.66208	244.374	218.372
5	438.8247	587.6315	530.2242	413.8899	285.43091	191.2727	152.353
6	193.1177	257.2118	329.4748	254.11832	187.0545	115.7462	84.96165
7	104.6687	94.8029	131.4991	176.61991	122.67027	81.84277	61.0138
8	33.50853	17.95736	27.39608	36.455779	53.688563	45.62702	36.87744
9	10.51813	7.00413	3.140242	3.5180259	9.210093	13.35245	9.181586
10	1.602011	2.513258	1.660901	0.6110112	1.040572	2.549329	3.190571

TABLE Black Sea turbot. PREDICTED CATCH NUMBERS AT AGE

Units : NA

age/year	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**
2	17.05511	19.83068	22.85843	24.13637	21.25942	18.68872	17.75736
3	162.4971	145.4657	147.0011	139.58169	151.96193	163.6107	164.1138
4	281.8176	300.5698	279.0721	286.03666	269.82403	286.3429	305.3443
5	336.8104	353.7322	401.3645	379.97672	373.28418	346.9775	358.9956
6	253.0254	271.7711	280.3391	287.95091	247.00782	232.3791	213.7998
7	184.0413	214.6524	219.6071	196.8437	188.51923	146.6648	135.4659
8	121.9669	129.1856	134.3865	122.64819	109.56303	95.32671	71.15282
9	42.46117	48.10374	48.2584	46.12154	42.05381	34.05647	29.69237
10	27.07931	27.41691	28.1912	26.23331	24.79693	20.77416	17.06057

age/year	**1957**	**1958**	**1959**	**1960**	**1961**	**1962**	**1963**

2	16.13967	21.5613	29.64253	24.364569	11.374796	15.61153	33.929
3	165.8079	178.0724	190.8256	175.44402	169.7183	171.8582	178.9685
4	312.3486	319.699	327.0457	312.68929	288.55047	274.9777	265.7856
5	379.21	375.0502	328.4386	268.16166	254.9634	228.8713	240.9164
6	238.7579	270.7592	254.2047	217.68956	219.84659	236.1908	239.698
7	87.38381	132.0948	149.2197	115.00091	113.71894	126.3013	168.0397
8	55.43494	50.91207	60.95769	65.879677	69.072729	70.35614	77.81389
9	16.07475	17.93206	16.38523	16.47691	19.52606	17.58085	17.07132
10	10.58322	8.620991	8.540675	6.751131	6.887375	6.721357	5.901815

age/year	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
2	24.49674	14.61956	23.18487	48.668889	36.793824	32.77087	39.22915
3	192.5912	176.2864	194.8149	199.16229	197.63858	164.1023	120.0154
4	263.3411	267.0992	237.1209	256.11076	250.27492	235.2691	179.9862
5	248.308	245.513	248.2733	215.98522	249.16866	276.5219	316.5623
6	220.8271	203.4642	207.1307	206.74786	188.65124	219.015	240.7984
7	137.078	117.2221	124.2257	97.827918	113.81678	108.4045	199.3137
8	78.69897	65.78356	58.84989	51.209753	43.968787	49.27023	56.13503
9	18.81981	19.2071	15.82119	14.76545	13.306465	13.81024	26.87133
10	5.556953	5.956124	6.061153	5.497536	5.278542	5.857893	10.7066

age/year	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**
2	2.906269	2.13385	2.789744	1.833213	0.578689	14.50335	18.95239
3	74.30216	53.09273	46.29621	40.045648	51.329211	64.07473	74.99639
4	131.1642	72.90885	47.37667	37.277503	36.478024	45.78424	49.81569
5	251.1097	209.248	161.2797	101.6779	111.73165	107.2208	128.8991
6	225.1665	211.3531	185.8593	126.09934	104.0769	103.2332	106.8227
7	155.5644	177.2799	184.4946	105.85498	69.018874	67.02462	88.10771
8	55.43327	59.86967	55.91821	33.227572	22.1016	22.42463	28.61755
9	21.22522	29.3464	31.35771	24.843844	14.490163	15.89032	19.56085
10	14.2368	18.78784	25.20923	25.17144	21.933606	26.25562	36.71517

age/year	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
2	17.77921	5.529957	10.42097	7.805355	0.1333457	0.074191	0.061126
3	76.477	76.02939	56.60911	35.052257	22.92367	15.05906	9.963416
4	59.87985	61.4553	55.53925	41.564232	28.546091	19.36137	11.78656
5	171.8084	218.7523	182.1026	156.45212	153.55518	116.4079	46.641
6	151.4204	201.5586	196.8161	169.22175	166.52576	128.2229	54.83014
7	105.8783	204.832	158.8436	170.16525	171.5509	167.7358	73.9227
8	37.64951	53.56094	61.82452	78.382446	83.033156	66.9804	38.37016
9	20.70965	33.07045	30.18545	44.508937	52.058079	51.23844	35.03333
10	40.75954	53.82726	49.06716	57.019311	67.314792	73.50842	65.11859

age/year	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
2	0.055842	0.057145	0.065244	0.1203971	7.006022	40.88855	60.02673
3	5.23465	3.617995	3.887165	4.7743603	9.29373	18.77751	35.20753
4	7.147767	4.791148	5.86698	7.0492413	15.643101	30.20628	51.78394
5	17.14077	13.74823	15.83812	22.677426	36.779109	55.55425	65.71387
6	22.71215	16.92666	28.53182	31.458525	41.695366	37.96786	35.83769
7	16.83264	13.44504	15.14151	24.351903	32.086648	31.44689	31.38971
8	8.915934	2.422643	9.534626	18.018338	22.536135	20.55964	14.72534
9	14.16154	4.235664	4.910423	10.707346	13.869747	11.91443	7.012961
10	36.99046	24.39797	57.57624	70.097701	62.037559	40.03964	17.69001

	1992	1993	1994	1995	1996	1997	1998
2	57.12947	223.8307	118.3907	55.677716	13.542461	0.032387	0.015165
3	59.56451	88.93182	81.01789	69.187485	57.341809	43.15378	41.88551
4	76.67686	128.9778	176.3164	159.36386	126.0943	91.90542	65.49213
5	66.23507	99.58485	172.4522	242.42685	165.55774	103.6707	89.72774
6	29.44017	42.10388	75.01439	146.29718	173.86341	115.8365	135.3833
7	17.69886	17.78757	42.7449	77.16531	94.054086	79.8572	101.1303
8	14.20466	19.45862	30.80971	41.124745	50.836774	67.16149	64.54031
9	4.070924	7.72097	15.17228	7.490009	8.324891	7.657151	8.026351
10	6.876226	5.939352	10.56144	6.319752	2.762428	1.672563	1.096301

age/year	1999	2000	2001	2002	2003	2004	2005
2	0.037125	26.33292	33.74999	63.250941	24.212039	17.94731	43.79939
3	53.41011	57.43306	54.85591	51.298935	53.023224	73.83257	106.3462
4	72.93656	86.32852	84.59118	74.382448	59.738697	68.81213	111.9609
5	75.96935	91.34285	117.2959	99.804173	74.89147	67.36597	86.2707
6	126.5301	98.52398	124.2543	101.77047	85.978735	74.16334	68.56279
7	146.1963	165.0354	98.84075	65.726356	81.808406	68.96368	94.90155
8	51.26406	51.77048	19.79284	5.6024836	16.811447	34.1875	50.42817
9	13.53962	25.10633	5.733063	1.4176393	0.9572685	4.547011	6.852476
10	1.918094	7.490983	3.659622	0.6774443	0.361046	0.353777	0.990904

age/year	2006	2007	2008	2009	2010	2011	2012
2	68.77154	80.0651	67.22734	35.54253	13.62001	83.4936	40.74284
3	120.5482	115.3026	89.34632	65.677736	47.444471	44.12471	35.18817
4	177.8748	219.471	200.6737	145.01106	97.126087	66.32786	60.8718
5	136.9944	200.4691	223.6987	187.72723	143.46628	88.57326	68.00084
6	79.83324	101.3115	121.6101	106.54954	87.530736	43.19523	29.95811
7	80.17165	60.4073	85.38667	109.29493	66.843897	37.39025	37.06785
8	24.35751	13.71061	22.37065	24.714744	36.571528	33.50886	29.29304
9	7.647815	5.349323	2.564881	2.3858155	6.2762333	9.810272	7.296173
10	1.164638	1.919216	1.3564	0.4142631	0.7090048	1.87307	2.535432

TABLE Black Sea turbot. CATCH AT AGE RESIDUALS

Units: NA

age/year	1950	1951	1952	1953	1954	1955	1956
2	-0.04519	-0.0048	0.04113	0.0458252	-0.0139855	-0.02351	0.018135
3	-0.2939	-0.05449	0.092777	0.19118	-0.0288847	-0.19338	-0.2078
4	-0.28106	-0.1515	0.150183	0.215653	0.0650555	-0.12679	-0.21125
5	-0.32473	-0.08331	0.081358	0.351048	0.0147248	-0.05534	-0.14165
6	-0.24253	0.007046	0.161452	0.0250175	0.122836	-0.17115	-0.0237
7	-0.11261	0.066006	0.110833	-0.0347906	0.0298964	-0.02593	0.310291
8	-0.1116	0.138828	0.064382	-0.118	0.112695	-0.18298	0.347416
9	-0.02155	0.099108	0.173217	0.028001	0.121895	0.0445	0.277738
10	-0.03895	0.079859	0.06137	-0.0162225	0.0270776	-0.05176	0.070819

age/year	1957	1958	1959	1960	1961	1962	1963
2	-0.09471	-0.02108	0.136119	0.149903	-0.279809	-0.10995	0.285216
3	-0.19614	0.303325	0.502717	-0.191291	-0.203211	-0.18999	0.22256
4	-0.06554	0.194429	0.589903	-0.32175	-0.0365114	0.024242	-0.1316

5	0.036997	0.461459	0.357852	-0.467594	-0.183077	-0.49926	0.154799
6	-0.17544	0.290619	0.308228	-0.375253	-0.102332	-0.19146	0.413459
7	-0.62548	0.254304	0.290943	-0.242795	-0.0618416	-0.18968	0.407792
8	-0.56216	0.223998	0.111755	-0.237809	0.176658	0.05833	0.370706
9	-0.54646	0.020184	0.151374	-0.388125	0.0527091	-0.0365	-0.17013
10	-0.35377	-0.00629	0.181622	0.221389	0.321513	-0.18901	0.096201

age/year	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
2	0.066799	-0.27702	-0.07558	0.272065	-0.0434676	-0.0766	0.707581
3	0.531543	-0.03239	-0.31129	0.187834	0.35521	0.573957	0.873193
4	0.181524	0.194162	-0.14857	-0.0887187	0.259785	0.462683	-0.04865
5	0.156385	0.135712	0.129891	-0.364702	-0.350679	-0.0899	0.947227
6	0.06747	-0.35497	0.287709	-0.15237	-0.116825	-0.34169	0.55097
7	-0.00392	-0.2018	0.316914	-0.244404	0.0078144	-0.51186	0.860295
8	0.092243	0.095203	0.353354	0.101847	0.217826	-0.36734	0.768397
9	-0.07722	-0.18679	-0.2897	-0.203037	-0.586107	-0.89788	0.674523
10	0.053848	0.291527	0.199389	0.222688	-0.0443712	-0.05037	0.916832

age/year	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**
2	-0.54125	-0.1485	0.227166	0.149988	-1.15855	0.741488	0.080628
3	-0.35391	0.255303	0.015681	-1.59185	-1.22901	0.244428	-0.36306
4	1.27972	-0.40728	0.290333	-1.54055	-0.185303	-0.28501	-0.84967
5	-0.39591	-0.05832	0.957389	-1.46688	0.471973	-0.0573	-0.99056
6	-0.38362	-0.02072	0.529698	-0.443594	-0.0911607	-0.22364	-0.28774
7	-0.44364	-0.0554	0.650594	-0.220928	-0.402588	-0.17866	0.055304
8	-0.52512	0.365255	0.6295	0.158301	-0.238644	-0.30489	0.062829
9	-0.43693	-0.07326	0.169396	-0.218231	-1.32576	-0.42885	0.44933
10	0.059432	0.360167	0.456501	0.312168	-0.53198	0.183233	0.380944

age/year	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
2	0.26632	-0.50091	0.237376	0.968581	-0.842934	-0.11708	-0.00238
3	-0.13804	0.538897	0.23666	0.617829	1.30904	1.89839	1.36212
4	-0.18899	0.58292	-0.31746	-0.580195	0.951434	1.74123	1.5351
5	0.23241	1.09627	-0.20328	-1.28213	0.485163	2.07409	-0.03372
6	-0.26093	1.07684	-0.03802	-0.466345	0.0626386	1.09088	0.687221
7	-0.32295	1.09752	-0.38453	-0.107152	0.0249532	0.720298	0.463721
8	-0.39944	0.718486	-0.43175	0.285856	-0.147456	0.282307	1.04491
9	-0.14314	0.854837	-0.3258	0.263941	0.589688	0.618443	0.511526
10	-0.16144	0.469119	0.039326	0.257366	0.574053	0.483043	0.419306

age/year	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
2	-0.01744	-0.02325	-0.11552	-0.858655	0.599047	0.357268	0.187296
3	-1.54127	-3.36555	-0.95915	-3.57518	1.02439	1.04073	0.995157
4	-1.23552	-3.27518	0.37045	-3.67858	1.03416	1.3289	0.56199
5	-2.42858	-1.81253	-0.40586	-0.264489	0.847321	0.940813	-0.14996
6	-2.13276	-2.32079	1.11017	-0.134524	1.06051	-0.05512	0.5869
7	-0.53013	-0.6923	-0.43903	0.0225734	0.416688	-0.38427	0.774351
8	-0.40402	-4.5508	0.684282	1.43799	-0.555315	0.014967	-1.07264
9	-0.28739	-0.94858	1.07155	-0.414788	0.255808	0.156649	-0.26332
10	-0.20847	0.157555	-0.20954	-0.156547	-0.111304	-0.07936	-0.71797

age/year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
2	-0.33497	0.766854	0.042205	0.215723	1.19669	-1.34946	-0.47817
3	-0.57728	1.14284	1.01254	-0.311568	-0.277043	0.296613	-1.24598

4	-1.0169	0.166903	0.258958	0.716351	0.0341707	-0.67798	-0.99658
5	-2.38513	-0.79512	0.305738	1.23195	0.0349963	-1.53383	-0.3519
6	-1.68833	-1.04933	-0.3781	1.12855	0.409336	-1.79894	0.568959
7	-0.7989	-0.99674	0.230899	0.630186	0.167455	-0.78438	-0.21388
8	-0.69115	-0.53715	0.476476	-1.50492	-0.344018	-1.40267	-0.31415
9	-1.11764	0.756404	1.52661	-2.14457	0.350881	1.09433	0.638007
10	-0.69636	-0.40755	-0.01543	-0.641832	-3.73325	0.444409	-3.17329

age/year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
2	-1.50626	1.64329	-0.19714	0.281047	-0.179014	-0.33647	0.139646
3	0.216567	0.434778	-0.20583	0.868873	-0.359121	-0.55669	-0.07867
4	0.480239	0.458139	0.483952	0.433853	-0.788936	-0.41542	0.244052
5	0.00514	0.292408	1.32014	0.469098	-0.575198	-0.16259	0.411634
6	0.810245	-0.48617	2.06298	-0.251947	-0.230414	-0.00826	0.339174
7	-0.00592	0.944642	0.25882	-0.120256	0.346046	-0.85912	0.682387
8	-1.34496	1.45799	0.21476	-0.104831	-0.0965269	-0.44192	0.759896
9	-0.1229	1.56928	-1.52602	-0.395669	-0.122389	0.2687	1.06812
10	0.808649	0.567146	0.50717	0.48264	0.270711	-2.40918	0.917785

age/year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	0.125784	0.098525	0.024886	-0.0372879	-0.751792	0.729353	-0.25168
3	0.129227	0.449535	0.081017	0.362783	-0.595467	0.091488	0.335512
4	0.624607	0.776816	0.091909	-0.136895	-0.222604	-0.42854	0.395593
5	0.936533	0.506348	-0.40973	-0.914237	-0.0483665	-0.76469	0.144918
6	1.07962	0.394135	-0.18299	-0.709723	0.623933	-1.21187	-0.31121
7	1.00396	-0.27278	0.40825	0.403133	-0.0981407	-1.1596	0.428323
8	-0.78948	-0.42582	0.71219	-0.0403093	-0.341553	0.039265	-0.32496
9	1.88306	1.72513	1.46702	0.720657	0.93983	0.862388	0.982699
10	-3.21414	-0.20782	0.395569	-2.58699	0.857813	0.607729	0.155364

TABLE	Black	Sea	turbot.	PREDICTED	INDEX	AT AGE	TR CPUE
Units	:	NA					

age/year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
2	12.58845	14.8144	20.86681	31.81761	48.62559	60.16977	55.3358
3	48.05855	54.31498	63.30346	87.46861	130.15551	199.7227	247.4627
4	79.21613	87.48436	97.9023	107.43865	144.39607	214.3543	328.8922
5	110.3845	114.6839	122.9073	124.63756	126.22045	176.068	265.775
6	115.6675	111.0833	104.4157	111.11881	106.1019	104.6164	159.1266
7	119.2056	119.5746	101.424	81.44924	97.95714	107.2991	107.4784
8	98.82889	103.9334	84.40106	57.67247	43.97758	66.25958	82.84654
9	65.42013	79.38346	66.7644	42.95702	26.92028	24.40724	42.25151
10	330.6697	224.0323	128.7329	62.23142	29.27254	17.77193	14.0111

age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
2	48.12876	39.6817	29.02885	29.861201	35.062423	34.76357	31.98733
3	209.6816	189.413	160.8673	118.13405	125.37259	148.1374	143.6788
4	398.7083	331.0469	306.4517	266.16329	191.5234	208.4752	242.4632
5	400.4665	457.1584	387.2188	395.8083	353.6402	245.3314	261.6506
6	234.5503	322.0897	332.6164	322.7345	357.58032	320.4736	196.9067
7	150.7873	195.1386	249.6725	261.91499	262.22686	232.6116	134.3005
8	56.88946	64.67793	66.655	83.930578	125.53317	137.9264	55.45157

9	36.00832	15.1406	14.02961	12.299271	20.065863	46.82232	34.56978
10	10.80523	5.507055	2.006857	1.158114	1.181481	2.859395	4.446423

age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
2	27.4512	30.16071	41.29205	56.001025	57.469823	49.01371	35.58414
3	125.7669	105.8486	114.3804	163.36713	224.52117	225.4459	187.0264
4	228.837	198.3831	165.1427	178.84688	253.11654	344.2747	329.1916
5	293.7503	280.6084	248.0276	205.26668	213.52203	292.5016	382.6115
6	187.2941	234.1659	237.6455	220.07315	172.44356	165.5263	224.4785
7	57.68978	97.32832	159.8267	192.40259	135.58246	86.51952	101.3004
8	17.97443	8.875459	33.50719	55.145768	70.940394	41.69203	20.50708
9	6.693119	2.886977	2.452591	9.4284338	12.391986	16.82759	10.28524
10	1.841777	0.59472	0.398763	0.3162286	0.7724739	1.10468	1.590744

age/year	**2008**	**2009**	**2010**	**2011**	**2012**
2	24.70783	18.0205	15.69497	13.626685	13.521486
3	131.6754	89.49475	66.58371	59.715403	45.428061
4	262.3842	181.9915	122.0145	94.159486	83.672469
5	321.3658	243.1674	159.1791	111.29563	90.164881
6	293.9119	216.6255	151.9407	102.89407	76.871869
7	137.7954	194.1323	149.011	109.6902	68.180595
8	26.78066	49.93739	73.11182	55.828808	38.689955
9	3.947175	6.196719	16.12886	21.010872	12.388022
10	0.899847	0.463833	0.785438	1.729333	1.855745

TABLE Black Sea turbot. INDEX AT AGE RESIDUALS TR CPUE

Units: NA

age/year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
2	-0.8792	-0.86483	0.635421	0.798566	0.871086	0.440441	0.827042
3	-0.76648	-3.11455	1.4562	1.25835	1.72379	-0.21775	0.633535
4	0.44764	-2.68608	1.44687	1.62351	1.56011	-0.29494	-0.34896
5	0.575155	1.21945	1.72238	1.52863	1.47208	-0.66698	-1.02899
6	1.62161	1.45573	1.76932	0.62202	1.22213	-0.34403	-1.23539
7	0.620271	1.45194	1.4304	0.812893	1.26441	-0.30919	-1.64057
8	0.791176	2.055	0.875348	0.814236	0.580825	-0.25412	-1.37346
9	0.740914	0.80008	1.05301	0.631965	0.757615	-0.74236	-0.93636
10	0.356334	0.826517	0.807124	0.647392	0.336064	-0.16837	-0.54902

age/year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
2	0.992446	0.862589	0.332259	-2.45617	-2.37387	-2.50725	0.834535
3	1.8654	0.520508	-0.53532	0.135894	-1.13925	-0.08181	0.698301
4	1.30966	1.79678	-0.13346	-0.806891	-0.710094	0.044547	0.583314
5	1.33852	2.0894	-0.12011	-1.38924	-0.34529	-0.51614	0.357416
6	0.610124	1.54312	0.217403	-0.912579	0.448207	0.083542	0.286434
7	0.823504	1.26928	-0.24229	-0.544365	0.236239	0.190137	1.68154
8	1.70106	0.825397	0.266238	-0.151053	0.40534	-1.07292	1.99726
9	2.00731	0.222927	0.381481	0.933234	0.658957	-0.67416	1.79845
10	1.01588	0.632955	-2.37577	0.945551	-1.89363	0.746221	1.34431

age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
2	0.114546	0.171619	0.028972	-0.16056	0.169478	0.459754	0.534949

3	-0.62638	-0.06641	-0.30316	-0.493822	0.193381	0.106794	0.452563
4	-0.21492	-0.89766	-0.73943	-0.450748	0.131078	0.011959	0.57945
5	0.13285	-1.16492	-0.70199	-0.424177	-0.0463783	-0.12712	-0.24207
6	0.740174	-1.17615	-0.27565	-0.342922	-0.492407	-0.04457	-0.32935
7	0.920323	-0.83981	0.153962	-0.660216	-0.533162	0.456412	-0.62672
8	0.529912	-0.94076	-0.07876	-0.0055368	-0.289797	-0.49744	-1.07219
9	-0.6647	-1.36097	-0.35349	-0.438338	-1.00719	0.705049	-0.38748
10	0.898788	0.23048	0.499104	-0.950826	0.342103	-1.71068	-0.38078

age/year	**2008**	**2009**	**2010**	**2011**	**2012**
2	0.459533	0.409455	-0.12749	0.521051	0.130037
3	-0.18429	0.481318	-0.53066	-0.874129	-0.270578
4	-0.10135	0.003134	-0.01777	-1.49671	-0.40384
5	-0.76844	-0.71652	0.283782	-1.54854	-0.692859
6	-0.9426	-1.00433	0.13411	-2.02396	-1.37771
7	-0.99943	-0.84821	-0.4157	-2.26001	-1.05484
8	-0.40629	-1.31183	-0.4678	-1.42889	-0.973031
9	-0.28257	-1.15945	-0.03764	-1.24531	-0.527828
10	0.12645	-1.62065	0.816761	0.0430634	0.0228894

Black Sea turbot. PREDICTED INDEX AT AGE UKR Trawl survey West

Units : NA

age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
4	18.47706	19.93207	26.49749	39.339929	60.069366	72.30982	35.22831
5	28.36483	27.73763	27.57777	39.862658	60.195645	89.45538	82.548
6	28.0506	30.44708	29.11199	29.269617	44.781271	64.75559	96.74416
7	36.45432	28.19459	35.13016	41.960135	42.016819	55.18328	90.79371
8	27.78983	17.80483	13.78636	22.688768	27.935827	15.52963	34.86767
9	33.56756	20.25071	12.88637	12.762102	21.755356	15.0096	8.510579
10	25.29028	11.46329	5.475261	3.631007	2.818937	1.759923	0.195802

age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
4	41.59001	36.02813	30.04722	32.435711	45.535853	61.29327	57.39574
5	65.618	63.36299	56.75933	46.668527	47.641299	64.23704	82.89046
6	45.73437	61.68372	64.17348	59.93616	45.999476	42.90679	58.79813
7	11.69955	28.93726	51.46233	67.110465	39.849506	23.01831	31.27784
8	3.645414	2.279988	9.319323	14.260736	17.413051	11.01469	5.15517
9	2.073386	1.132787	1.04192	3.7241551	4.6460621	6.790537	3.949267
10	0.222936	0.091182	0.066194	0.0488071	0.1131671	0.174185	0.238666

Black Sea turbot. INDEX AT AGE RESIDUALS UKR TRAWL survey West

Units : NA

age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
4	0.461922	-0.65905	0.689474	-0.064188	-1.12763	-1.48397	-0.94342
5	0.588167	-1.77111	0.188666	-0.469275	-0.306268	-1.41755	-1.01031
6	0.967183	-1.31933	-0.02742	0.666322	-0.646876	-1.68868	0.609624
7	-0.87248	-0.56482	-0.7641	-0.634932	-0.37001	-0.86198	-0.401

8	-0.99623	-0.41616	-1.06862	-1.24871	0.0495192	0.590077	0.061645
9	-1.37476	-0.92198	-1.2408	-0.939856	0.153218	0.514262	0.277402
10	-0.50744	-0.3291	-0.88109	-0.614827	0.336688	0.547085	-1.4515

age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
4	0.602065	0.52276	-0.38531	0.549586	-1.22049	1.66644	1.55278
5	0.430107	0.886565	0.162851	0.649211	-0.135546	1.47892	0.97188
6	-1.76589	0.131701	1.02471	1.0067	0.170131	1.29318	-0.08575
7	-1.47681	0.955162	1.56867	0.696612	1.36765	1.2337	0.371419
8	-1.70549	1.0794	1.25782	1.0407	1.37853	-0.33252	0.555542
9	-1.26756	0.292161	0.639125	1.35338	1.17448	0.443528	1.21992
10	0.522177	1.11179	1.38024	-0.773585	1.63539	-1.39441	0.823377

Black Sea turbot. PREDICTED INDEX AT AGE UKR Trawl survey East

Units : NA

age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
2	0.244461	0.367857	0.562574	0.6989074	0.6157114	0.547419	0.412692
3	0.776315	1.067729	1.582785	2.4242059	2.9912459	2.529908	1.518063
4	1.807414	1.94975	2.591975	3.8482558	5.8759632	7.07332	3.44602
5	2.655083	2.596369	2.581408	3.7313496	5.6345653	8.3734	7.72684
6	3.114847	3.380995	3.232707	3.2502113	4.9726853	7.190711	10.74285
7	3.649718	2.822746	3.517147	4.2009051	4.2065801	5.524761	9.089955
8	2.156406	1.381605	1.069782	1.7605848	2.1677418	1.205057	2.705641
9	1.327149	0.800643	0.509485	0.5045693	0.8601384	0.593433	0.336479
10	3.797413	1.721247	0.822131	0.5452074	0.4232742	0.264258	0.029401

age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
2	0.314689	0.341602	0.477613	0.6501475	0.6631089	0.560517
3	1.499689	1.25804	1.361383	1.9459514	2.6704687	2.670405
4	4.068319	3.524258	2.939208	3.1728492	4.4543004	5.995745
5	6.14212	5.931043	5.312912	4.3683703	4.4594257	6.012857
6	5.078521	6.849598	7.126071	6.6556093	5.1080105	4.764535
7	1.171322	2.897099	5.152232	6.7189373	3.9895961	2.304512
8	0.282875	0.176921	0.723154	1.1065909	1.3512053	0.854713
9	0.081975	0.044787	0.041194	0.1472417	0.1836892	0.268474
10	0.033475	0.013691	0.009939	0.0073285	0.0169924	0.026154

Black Sea turbot. INDEX AT AGE RESIDUALS UKR Trawl survey East

: NA

age/year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
2	0.955369	0.406268	1.02571	1.21011	0.856494	1.10727	-1.61095
3	1.50392	0.332117	0.412572	1.31576	0.775497	1.23066	-0.8957
4	1.37651	0.753563	1.31787	1.05732	0.435926	0.697409	-1.06457
5	1.28632	0.502901	1.46352	0.911071	0.985679	1.04451	-0.81007
6	1.26687	0.509685	1.21661	1.1581	0.712507	0.795745	-0.12161
7	0.5215	0.744932	0.611834	0.653643	0.822528	0.99159	-0.5951
8	0.218397	0.580912	0.27246	0.0722725	0.826113	1.42054	0.082585
9	0.395935	0.624894	0.615064	0.588766	1.08729	1.49523	-1.72098

10	-0.26557	0.094137	-0.71139	-0.459024	1.23735	2.04261	-0.92902

age/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
2	-1.49354	-1.52908	-0.28032	0.0618696	-0.158367	-0.42513
3	-1.03203	-0.38381	-0.75398	0.39933	-1.27206	-1.49067
4	-0.97721	-0.8881	-1.04037	0.571392	-0.716762	-1.42638
5	-1.5499	-0.78888	-0.66862	0.0636847	-0.907704	-1.45215
6	-0.49919	-1.20799	-0.51765	-0.379169	-1.16669	-1.65737
7	0.697376	-0.61429	0.109248	-0.506184	-2.5578	-1.00627
8	0.537386	0.040429	0.370393	0.563432	-2.78101	-1.06749
9	-1.02978	-0.05533	0.324882	-1.31645	-1.42471	-0.14412
10	-1.04082	0.326473	1.39172	0.267748	-0.456728	-0.82823

Black Sea turbot. PREDICTED INDEX AT AGE RO Trawl survey

Units : NA

age/year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
4	124.8783	135.2412	191.4028	260.33519	248.93206	198.4109
5	105.1891	87.05499	90.55614	124.05066	162.26812	136.2934
6	71.88661	66.57106	52.16334	50.0709	67.903664	88.90692
7	29.65854	35.70355	25.15961	16.055155	18.797991	25.57026
8	0.695091	1.143974	1.471623	0.864883	0.4254116	0.555552
9	0.030389	0.116824	0.153544	0.2085034	0.12744	0.048908

age/year	**2009**	**2010**	**2011**	**2012**
4	137.6191	92.26547	71.20194	63.271817
5	103.1279	67.50894	47.20123	38.239538
6	65.52816	45.96131	31.12465	23.253368
7	36.02489	27.65178	20.35507	12.652186
8	1.035927	1.516667	1.158143	0.8026047
9	0.076781	0.199846	0.260337	0.1534946

Black Sea turbot. INDEX AT AGE RESIDUALS RO Trawl survey

age/year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
4	-0.94189	-1.28829	-0.889	-0.989308	-0.0272081	0.23602	-0.01455
5	-0.8344	-0.19978	-0.22608	0.265073	-0.727197	-0.5044	0.065519
6	-0.03814	0.03863	-1.13092	-0.465816	-1.38498	-1.38679	-0.17665
7	0.426248	-1.13385	-0.58907	-0.563772	-0.498188	-0.89922	-0.01189
8	-1.24601	0.782775	0.784773	-1.31021	-1.10177	-1.18018	0.78964
9	-0.38262	-0.84615	-0.94024	-1.04557	-0.876097	-0.54642	1.68031

age/year	**2010**	**2011**	**2012**
4	0.534354	1.50683	1.21138
5	0.647473	1.82041	2.25595
6	0.06409	1.17409	1.91896
7	-0.07908	0.927311	2.16147
8	0.614404	0.981799	0.945675
9	0.873814	1.1211	1.10195

Black Sea	turbot.	PREDICTED	INDEX	AT Age	BG Trawl	survey	
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	89.2231	64.77631	44.97694	32.80398	28.57037	24.80537	24.61411
3	151.1859	125.4215	88.30264	60.01653	44.65159	40.04565	30.46474
4	152.1535	145.4889	115.9617	80.43183	53.92531	41.61414	36.97936
5	91.98449	120.3218	101.0616	76.47011	50.05788	35.00007	28.35462
6	37.7313	51.16931	66.99647	49.37924	34.63449	23.45444	17.52275
7	12.09848	14.16537	19.26866	27.14682	20.8372	15.33871	9.534149

Black Sea	turbot.	INDEX	AT AGE	RESIDUALS	BG	Trawl	survey
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
2	0.868669	0.618704	1.2705	-0.473091	-1.63918	0.413968	-0.87123
3	0.629334	0.724322	0.34843	0.987188	-2.0605	-0.05118	-0.50896
4	-0.54596	1.32525	1.01033	0.862559	-1.30235	-0.74431	-0.55631
5	-1.09713	0.72635	1.35124	0.971044	0.188563	-1.01112	-1.05699
6	-0.74278	0.940841	1.55897	1.30338	0.117398	0.206846	-1.0235
7	-0.48726	-0.10262	0.109712	0.469994	-0.589092	1.30089	-1.42278

Black Sea turbot. FIT PARAMETERS

name	value	std.dev
logFpar	-3.0342	0.58787
logFpar	0.41513	0.5003
logFpar	-2.3286	0.17904
logFpar	-1.4968	0.1184
logFpar	-0.94291	0.11731
logFpar	-0.12377	0.18737
logFpar	0.13104	0.2948
logFpar	0.80534	0.32475
logFpar	-0.97582	0.67414
logFpar	-7.4433	0.64426
logFpar	-5.8087	0.38918
logFpar	-4.6532	0.29858
logFpar	-3.8654	0.31441
logFpar	-3.1407	0.31396
logFpar	-2.4252	0.25538
logFpar	-2.8719	0.5124
logFpar	-2.4351	0.44077
logFpar	-1.849	0.36136
logFpar	-1.5316	0.26493
logFpar	-1.2936	0.29643
logFpar	-1.2775	0.14066
logFpar	-1.4495	0.25212
logFpar	-0.71508	0.22279
logFpar	-0.13678	0.20339
logFpar	0.20114	0.23007
logFpar	0.68978	0.19984
logFpar	1.0056	0.21048
logFpar	1.2566	0.25542

logFpar	-0.99455	0.12459
logFpar	-2.8699	1.0847
logFpar	-3.1342	0.94532
logSdLogFsta	0.59998	0.20974
logSdLogFsta	-0.96179	0.14651
logSdLogN	-1.2878	0.12375
logSdLogN	-3	1.52E-07
logSdLogObs	-0.1383	0.50066
logSdLogObs	0.21392	0.11885
logSdLogObs	-0.06702	0.11958
logSdLogObs	-0.57106	0.15527
logSdLogObs	-0.77006	0.16247
logSdLogObs	-1.6576	0.45972
logSdLogObs	-0.64967	0.11529
logSdLogObs	0.39218	0.10459
logSdLogObs	-0.52593	0.23632
logSdLogObs	-0.40421	0.19355
logSdLogObs	1.225	0.22495
logSdLogObs	1.0664	0.22961
logSdLogObs	-0.45486	0.20055
logSdLogObs	-0.93408	0.15455
logSdLogObs	-0.45172	0.22047
logSdLogObs	0.010946	0.20487
logSdLogObs	-0.08871	0.23651
logSdLogObs	0.71749	0.19792
logSdLogObs	0.83693	0.19763
logSdLogObs	0.32399	0.20016
logSdLogObs	0.054227	0.20151
logSdLogObs	0.10935	0.11966
logSdLogObs	0.56768	0.20085
logSdLogObs	0.71441	0.20422
logSdLogObs	0.14913	0.22393
logSdLogObs	0.049948	0.28591
logSdLogObs	-0.156	0.29036
logSdLogObs	-0.48783	0.30803
logSdLogObs	-0.31792	0.29989
logSdLogObs	-0.57483	0.30563
logSdLogObs	-1.3405	0.46516
logSdLogObs	1.0904	0.13927
logSdLogObs	0.21784	0.14163
logSdLogObs	0.096608	0.14258
logSdLogObs	0.005929	0.1437
logSdLogObs	0.13914	0.14315
logSdLogObs	-0.02937	0.093238
logSdLogObs	0.66352	0.14653

Black Sea turbot. NEGATIVE LOG-LIKELIHOOD

1656.71

Multiple SAM model runs were done to test the effect of different combinations between tuning series on SSB, recruitment and fishing mortality. Among the others, a run excluding the Romanian tuning fleet, was performed. The observed effects were large in terms of SSB (i.e. around 60% lower SSB in the last year) but not significant in F and recruitment, and nevertheless do not affect the perception of the stock status. Thus, STECF EWG 13 12 Black Sea assessments decided to use the all available tuning series in the analysis.

The SAM estimated recruitment has four peaks in 1965 – 1968, 1974 – 1977,1991 – 1994 and 2003 – 2006 and three lows in 1982-85, 1996 – 1997 and 2004 - 2006. Correspondingly, SSB attained higher values up to 14 255 t in 1976 – 1982 and very low values after 1989. For the recent period however the STECF EWG 13 12 Black Sea assessments is aware that misreporting of actual catches might be larger than assumed in the assessment (around 1.82 the official catches) especially for Bulgaria and Ukraina. Fishing mortality $F_{4\text{-}8}$ has a peak of F~1.25 in 2000-2001 and keeps as high as F = 0.6 - 0.86 thereafter (Fig. 6.2.4.1.3.2).

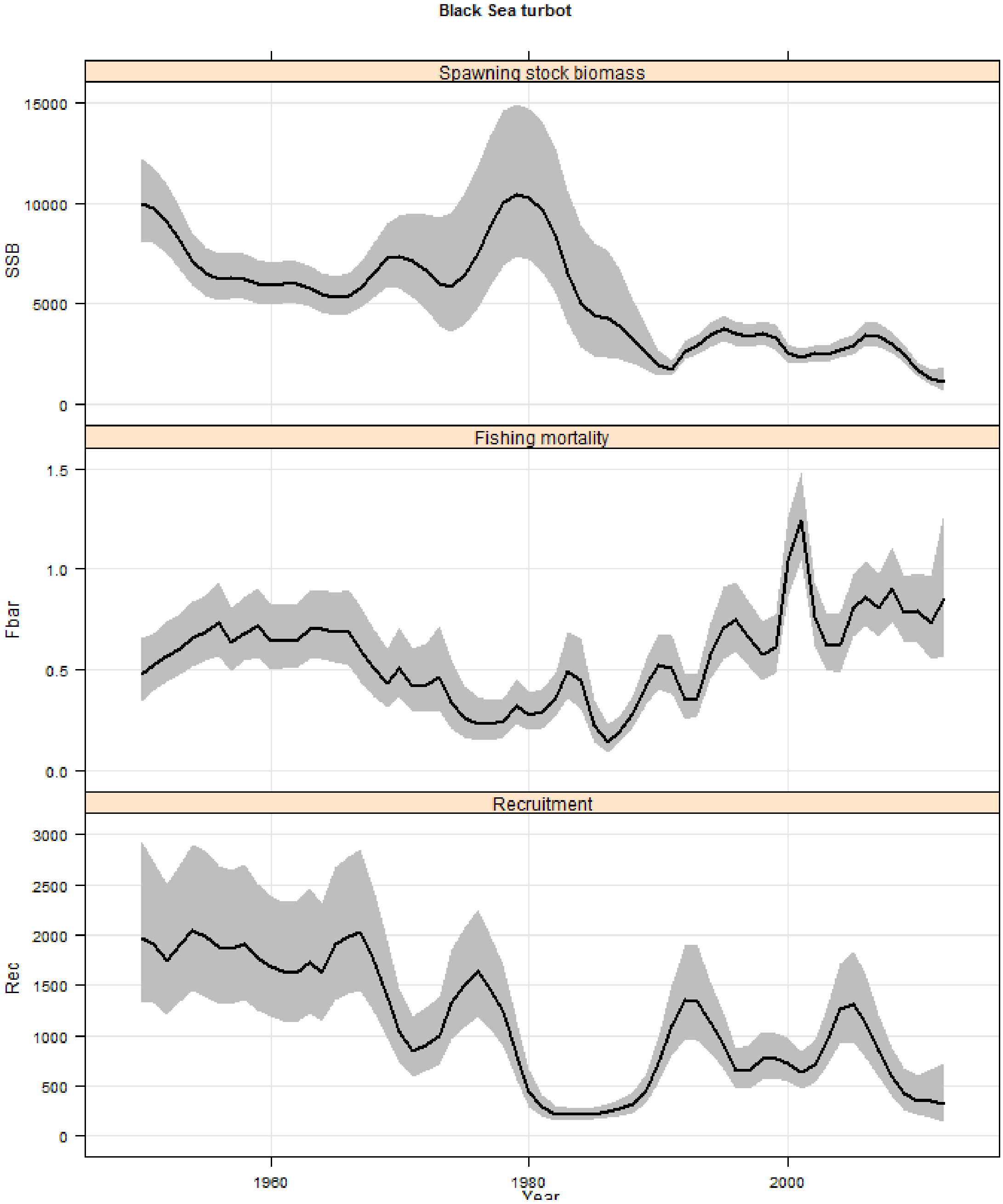


Fig. 6.2.4.1.3.1. Time-series of population estimates of Black Sea turbot (SAM final model): SSB, F (ages 4–8) and recruitment with estimate of uncertainty.

6.2.5 *Short term prediction of stock biomass and catch*

The STECF EWG 13-12 made qualitative assumptions about the IUU (Illegal, Unregulated and Unreported) fishing of turbot and estimated the Potential Unreported Catch in 2012. The estimates are considered to reflect the actual level of misreported catches of turbot in the Blakc Sea,

However, given the stock status, i.e. the F is more than 3 times higher than F_{msy} and the SSB is about one third of the estimated B_{lim}, the STECF EWG 13-12 did not undertake the short term projections for this stock.

6.2.6 *Medium term prediction of stock biomass and catch*

Given the status of the stock, the EWG 13 12 did not undertake medium term projections.

6.2.7 *Long term predictions*

Given the status of the stock, the EWG 13 12 did not undertake long term projections.

6.2.8 *Data quality*

The available data for turbot stock assessment in 2013 is considered good enough in order to perform a reliable assessment of the stock. The share of IUU fisheries by countries was not reported but it was estimated and included in the catches. No data were provided by countries regarding the discards.

6.2.9 *Scientific advice*

6.2.9.1 Short term considerations

State of the spawning stock size: The SAM analyses indicate that the stock size is at a historic low (around 1100 t) and it is around one third of the estimated B_{lim} (2914 t). F in 2012 (0.85) is more than three times higher than F_{msy} (0.26).

State of recruitment: Recruitment has increased since 2003 but this has not yet materialized in a significant increase in SSB. However, the last years classes (2006-2010) are among the lowest observed in the time series,

State of exploitation: The STECF EWG 13 12 propose F_{msy} to be equal to 0.26 (i.e. F which maximises average catch in the long run)as limit reference point consistent with high long term yields. F is at the historical high level around 0.85, more than3 times F_{msy}.The EWG classifies the stock of turbot in the Black Sea as being exploited unsustainably and at the risk of collapse. The EWG notes that despite the recently low TACs the fishing mortality remains at high level with no signal of reduction. STECF consider that on the basis of precautionary considerations that there should be no directed fisheries and bycatch should be minimised.

6.2.9.2 Estimation of reference points for Black Sea turbot

6.2.9.2.1 *Introduction*

Reference points (biomass and exploitation rates) were estimated for Black Sea turbot. Estimation of reference points was done based on the methodology described in Simmonds et al., (2011) which originated as a working document to the 2010 WKFRAME meeting (Anon., 2010). The framework uses computer intensive methods to estimate MSY (Maximum Sustainable Yield) reference points and calculates for a given value of B_{lim} corresponding F_{lim} reference points. These reference points have a probabilistic interpretation, for example two of the F_{lim} reference points calculated are the F that gives a 5% probability of SSB (spawning stock biomass) falling below B_{lim} (denoted F_{lim5}) and the F that gives a 10% probability of SSB falling below B_{lim}. Other F reference points are F_{msy}: the median of the Fs that give the maximum sustainable yield and $F_{msy\ catch}$: the F that gives the maximum average yield. The method also attempts to estimate a B_{lim} by using the location of the breakpoint in a fit of the hockey-stick stock recruitment (SR) function.

6.2.9.2.2*Methodology*

The methodology follows that in Simmonds *et al.* (2011), there were some refinements of the model averaging methodology largely of a technical nature.

The approach follows that of a typical medium term projection but it includes the uncertainty in the choice of the stock recruitment model. Three models were investigated: the Ricker, the Beverton and Holt and the Hockey-stick models. Bayesian model averaging was used to combine the models giving appropriate weight to the best fitting models. The result is an algorithm which simulates recruitment given an SSB estimate while incorporating error not just in the fit of the individual model parameters (parameter uncertainty) but also incorporating error in the choice of model (model uncertainty). The method in Simmonds *et al.* (2011) uses an estimate of the posterior model probability from Gammerman 1997, then samples independently from the parameter distribution in each model, selecting which model to sample based on the estimate of the posterior model probability. This was changed and the approach taken here is to sample from the joint distribution of models and parameters (as in Madigan and York, 1995 and discussed in Hoeting *et al.*, 1999), which is more appropriate.

The inputs to the medium term projection were mean weight at age in the catch, mean weight at age in the stock, selectivity at age, maturity and natural mortality. For each year in the projection, sets of these values from 2010 to 2012 were chosen at random by selecting a year and using the same compliment of selectivity and weights at age and other parameters to maintain any within year correlation while also adding some noise that reflects current variations in these quantities. The simulations were initiated with a recruitment equal to the mean geometric mean of the series, and other inputs such as proportion of F before spawning and proportion of M before spawning were fixed based on a three year average (though these quantities do not change).

The projection was run for 200 years and reference point calculations were based on the last 50 years (i.e. it is assumed that equilibrium is reached before 150 years). A range of F_{bar} values (40 in total) were simulated between 0 and 1 and for each F_{bar} value 5000 simulations were conducted. In absence of a clear breakpoint in the hockey stick SR function, B_{pa} was defined as 40% of the maximum observed biomass (SSB_{max}) taking this to be a proxy for the virgin biomass following Cardinale et al., 2012. B_{pa} was defined as 1.4 x B_{lim} (ICES 2011). Thus, B_{lim} is defined as SSB_{max} divided by 1.4.

6.2.9.2.3*Results*

- Turbot in the Black Sea
- The data

The stock recruitment data are plotted in Figure 6.2.9.2.3.1. It shows an approximately linear relationship between SSB and recruitment. The data presented on this plot are from the final assessment (see section 6.2.4).

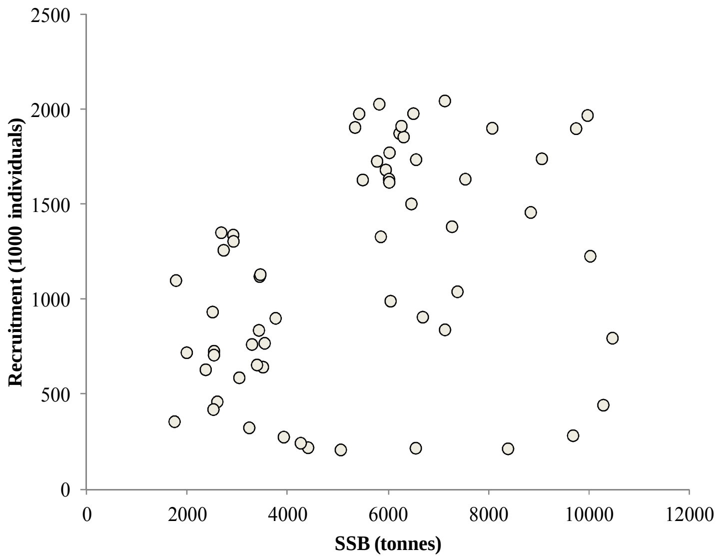


Figure 6.2.9.2.3.1. Stock and recruitment data for turbot in the Black Sea as estimated from the latest stock assessment (see section 6.2.4 of this report).

The data used in these simulations is shown in Figure 6.2.9.2.3.1. The fits of the individual stock recruitment models are shown in Figure 6.2.9.2.3.2 along with a figure showing 500,000 simulations of recruitment after accounting for model and parameter uncertainty. The overall fits is poor, as there is no strong signals from the SR data for Black Sea turbot.

The results of the simulations are given in figures 6.2.9.2.3.2 and 6.2.9.2.3.3 and the reference points estimated are shown in table 1. It was not possible to use the estimate of B_{lim} from the hockey stick recruitment model break point since it was not well defined. A pragmatic alternative is to define B_{pa} as 39% of the maximum observed biomass (SSB_{max} = 10461 tonnes) taking this to be a proxy for the virgin biomass following Cardinale et al., 2012. B_{pa} was then estimated at 4080 tonnes. B_{pa} is usually defined as 1.4 x B_{lim} (ICES 2012). Thus, B_{lim} is defined as B_{pa} divided by 1.4, which corresponds to 2914 tonnes and this is the value used to estimate F_{lim}.

Table 6.2.9.2.3.1. Estimated reference points. F_{lim5}, F_{lim10} are the F values that give a 5%, 10% probability of SSB falling below B_{lim}. F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. B_{pa} was defined as 39% of maximum observed SSB, B_{lim} is defined as B_{pa} divided by 1.4.

B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{MSY}	$F_{max\ Catch}$
2914	4080	0.37	0.40	0.31	0.26

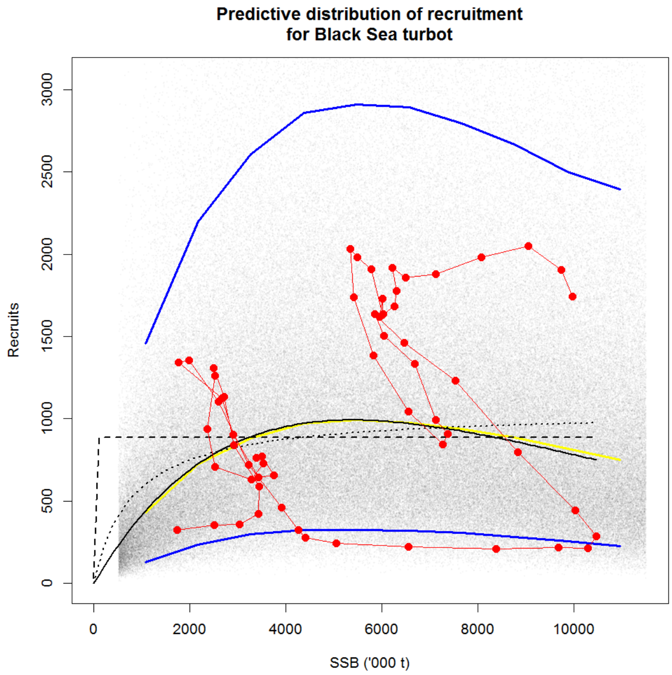


Figure 6.2.9.2.3.2. Stock-recruitment model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles with the SR model fits (Hockey-stick, Ricker and Beverton and Holt) along with 5000 simulated recruitment relationships showing the parameter uncertainty at different level of SSB accounting for both parameter and model uncertainty.

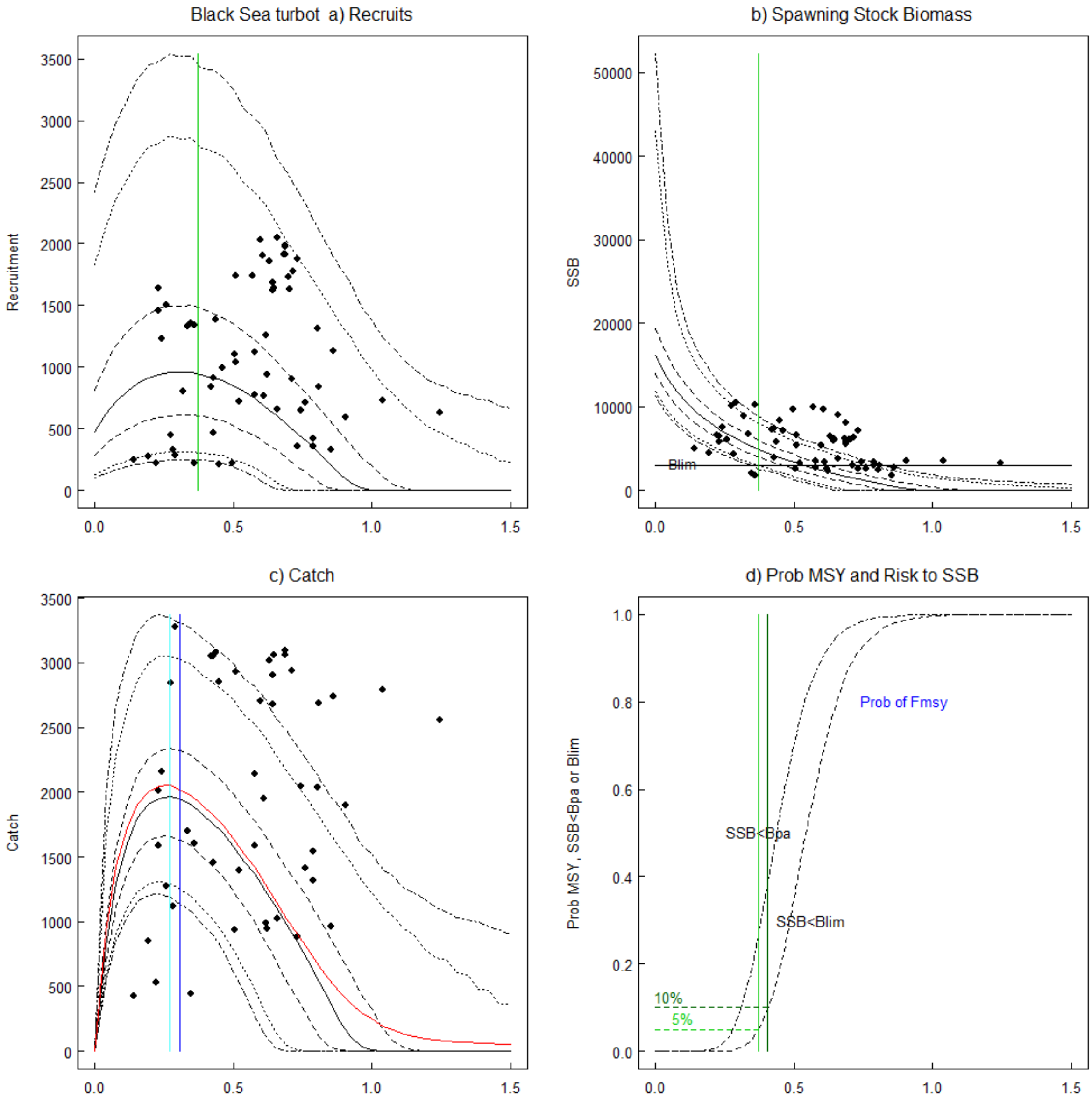


Figure 6.2.9.2.3.3. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar}, the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5}. Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5}. Panel c) shows catch against F_{bar}, here a red line shows average equilibrium catch, which is maximised at $F_{max\ catch}$ indicated by a vertical light blue line and F_{msy} indicated by a vertical blue line. In the final panel (d) two distributions are shown: the probability of SSB falling below B_{lim} and B_{pa}.

6.3 Whiting in the Black Sea

6.3.1 *Biological features*

6.3.1.1 Stock Identification

In the Black Sea, the whiting is one of the most abundant species among the demersal fishes. It does not undertake distant migrations, spawning mainly in the cold season within the whole habitat area (Fig. 6.3.1). The whiting produces pelagic juveniles, which inhabit the upper 10-meter water layer for about a year. The adult whiting is cold-living, preferring temperatures 6-10 C. Fishes at the age less than 6 years are predominant in the whiting populations, the older year classes are found in catches individually. It occurs all along the shelf, dense commercial concentrations are formed by 1-3 year old fishes in the water down to 150 m depth, most often at 60-120 m depths (Shlyakhov, 1983; Ozdamar *et al*, 1996). Such concentrations on the shelf of Bulgaria, Georgia, Romania, the Russian Federation and Ukraine not do from every year, appearing at periods of 4-6 years - in the years of appearance of highly productive year classes. In these countries, whiting is very rarely the target species for fisheries and yielded as by-catch during trawl fisheries for other fish species or while non-selective fisheries with fixed nets in the coastal sea areas (Shlyakhov and Daskalov, 2008).

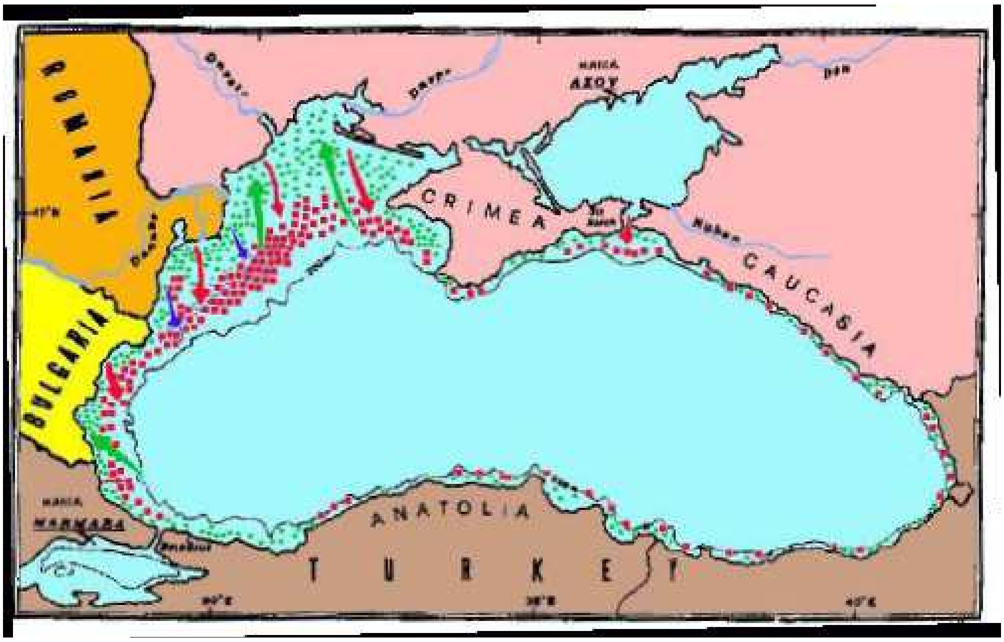


Fig. 6.3.1. Map of distribution of Whiting in the Black Sea

In the vicinity of the southern coast of the Black Sea whiting concentrations are more stable. Turkey is the only country in the region, where the annual target trawling fisheries for this fish is conducted. Thus, about99% of the catch of blue whitingfromthe 1990snow goes to Turkey, although the area of itscontinentalshelf in the BlackSea does notexceed 10%.

There are four methods of whiting fishery in Turkish Black Sea coasts. The first is trawl nets and caught 82.1% of total catch and the mean length was 16.1 cm by this method. Gill nets were also used in whiting fishery and obtained 13.6% of total catch by a mean length of 18.2 cm. The rest percentages of 3.7% caught by purse seines and 0.6% by lines with mean catch lengths of 16.0 cm and 19.6 cm, respectively (Zengin et al., 1998). As it is seen above, the bottom trawl fishery is the major method in whiting fishery.

The problem of units for whiting stocks in the Black Sea has not been settled yet. Fisheries experts from the Black Sea Commission specify the stock as shared that is although this fish does not make long migrations; its whole stock (or two different stocks – Eastern and Western) is exploited by each Black Sea country in their waters. In this case,the part ofthe stock (or local stocks) that is distributedoutside theTurkishwaters,practicallyunexploited.Therefore, the estimates F and stock size obtainedfrom the analysis ofonly thefishery and biological datadoes nothave a lot ofregionalvalue for whiting.

According to Bulgarian assessment (Prodanov and Bradova, 2003), whiting biomass in the western part of the Black Sea excluding the western Turkish coastal waters in 1997 was assessed by VPA as 121 thousand tons, which was comparable with the long-term mean after decline in 1990 – 1991.
Along Georgian coasts after the disintegration of the USSR whiting biomass assessments were not made, but on the basis of monitoring the scientists from this country make conclusion that in the period from the early 1990s until the mid-2000s the whiting abundance as well as of other bottom fishes increase (Komakhidze *et al.*, 2003).
In Romanian waters in 1996 – 2012 whiting remained the most abundant among bottom fishes although its mean annual catch reduced as much as four times as compared with 1989 – 1995. Partially it was caused by reduction of fishing efforts as compared with previous period (Nicolaev *et al.*, 2003). The stock biomass was assessed at 5500-9000 tons by swept area method (bottom trawl surveys).
In the Russian sector of the Black Sea trawl survey show that stocks of whiting and other *Gadidae* (*Gaidrosparus mediterraneus*) are estimated about 7.6 – 8 thousand tons and the annual TAC for whiting averages 2 thousand tons (Volovik, Agapov, 2003).
Along the Turkish coasts the total biomass of whiting in local areas were estimated by A. İşmen (2003). In 1992 the highest biomass between Sinop and Sarp (eastern Black Sea), which is an area, closed to trawl fishing – 30 thousand tons. In 1990 the biomass of whiting between Sinop and İğneada (western Black Sea) was estimated within the range of 1.1 – 1.7 thousand tons. Even if for the period of 1996 – 2012 similar direct assessments of whiting biomass were made, they were not published.
In 1992 – 1995 in the waters of Ukraine whiting biomass changed from 43 up to 70 thousand tons, on average 54 thousand tons, and for the subsequent decade – from 40 up to 68 thousand tons, on average 52 thousand tons (Shlyakhov, Charova, 2006). In2007-2011, in accordance with the estimatesYugNIRO (estimation methods have been used, notrelated to the analysisof fisheries statistics), whitingstockinUkrainianwatersranged30-55 thousand tons on average 46 thousand tons.Itschangeswere due tofluctuations inrecruitmentandnoclear trend.In comparison with the1992 - 1995averageSSBwhitinginUkrainianwatershas decreased by12%.It should benoted thatwhiting specialized fisheries is fully absent, and Ukrainian trawling fisheries are not conducted on the grounds with the densest whiting distribution.
By this reason the most realistic assessments of the stock abundance seem to be estimates according to the data of trawl surveys or surveys produced on the basis of analysis of fisheries with obligatory correction for discard and unregistered by-catch. In order to make rough assessment of the present state of whiting stock and the extent of its exploitation by fisheries (underexploitation – exploitation at the target level – overfishing), let address to the assessments of allowable catch assessments in the various parts of the habitat area of this species.
As regards the levels of the reference points of whiting (Raykov *et al.*, 2008), in western part of the Black Sea the lowest level of Fmax was established in Romanian waters: 0.52 and the middle level were established in Bulgarian waters: 0.61 and the highest - 0.68 was detected in Ukrainian waters. If to consider the value of this coefficient of natural mortality as constant and equal M = 0.70 (Prodanov *et al.*, 1997), and Fmax = 0.60, so with favorable state of whiting population the highest level of annual capture makes up 33.6% of its initial stock. Estimates ofMSYforwhitingwatersof Bulgaria andRomaniaobtained byonproduction Schaeferand Foxmodelsare in the range596-607tones (Raykov et al, 2008).

6.3.1.2 Growth and mortality

The determination of the biologic parameters represents an important objective for the establishment of the demographic structure, the growth parameters, as well as other parameters required for the study of recruitment, mortality, effective and biomass, divided into age classes. In the Black Sea former USSR waters in areaswith a narrowshelf whiting population was characteristic of predominance of larger-sized fishes than in the grounds with wide shelf (Shlyakhov, 1983). In 1996 – 2005 in the grounds of intensive Turkish trawl fisheries one can observe tendency to reduction of mean length of fishes which became equal or even less than in Ukrainian waters. It is not quite typical and in our opinion it is the evidence of excessive intensity of fishery. Turkish scientists came to the same conclusion. Thus, according to materials of 2000 Genç *et al.* (2002) applying methods of LCA and Thompson and Bell found that modern whiting fisheries in the waters of Turkey is conducted with excessive MSY due to trawls with mesh size less than 22 mm. İşmen (1995, 2006) estimates existing fishing intensity as F=1.24 and considers possible to achieve optimal exploitation of whiting by means of decrease in fishing intensity or enforcement of a minimum allowable total length. Thus, whiting stock in the waters of Turkey may be characterized as excessively exploited. In 2011-2012 length and weight frequency distributions of whiting were presented in (Figure 6.3.1.2.1). The mean length and body weight is found respectively 11.96±0.08 (5.1-22.70) cm, and 14.83±0.35 (2.0-120.77). The age range was determined as 0-8 years. The von Bertalanffy growth parameters were estimated as $L_{oo=}37.05$ cm, K=0,102 year^{-1} and t_0=-1.641 year and the constant and slope in length- weight relationship were calculated as 0,004 and 3,188 (Rsq= 0.97) respectively for whole sampling periods in 2012 (Fig. 6.3.1.2.2).

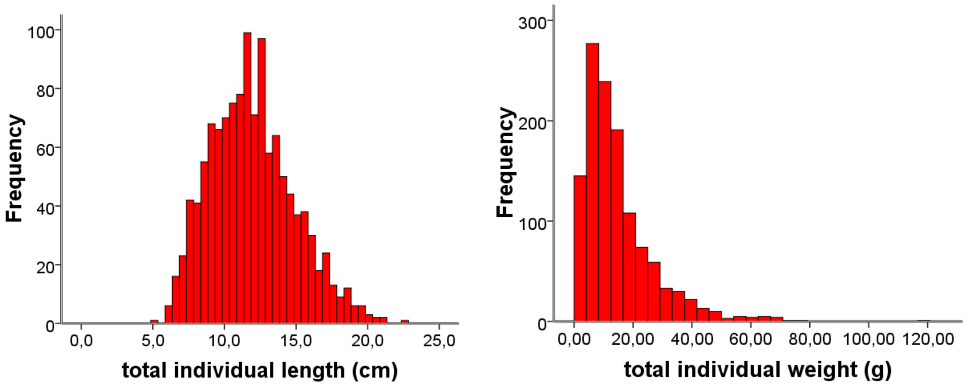


Fig.6.3.1.2.1.Length and weight frequency (n=1225) distributions of Whiting for spring 2011 from Samsun shelf area

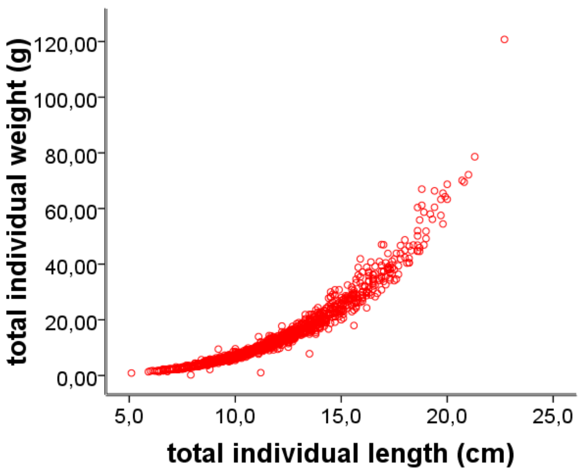


Fig.6.3.1.2.2. Length-weight relationship of the Whiting population (n=1225) in 2012

The length and weight frequency distributions were presented in Fig. 6.3.1.2.1. The mean length and body weight is found respectively 11.96±0.08 (5.1-22.70) cm, and 14.83±0.35 (2.0-120.77). The age range was determined as 0-8 years. The von Bertalanffy growth parameters were estimated as $L_{oo=}37.05$ cm, K=0,102 year^{-1} and t_0=-1.641 year and the constant and slope in length- weight relationship were calculated as 0,004 and 3,188 (Rsq= 0.97) respectively for whole sampling periods in 2012. (fig. 6.3.1.2.2).

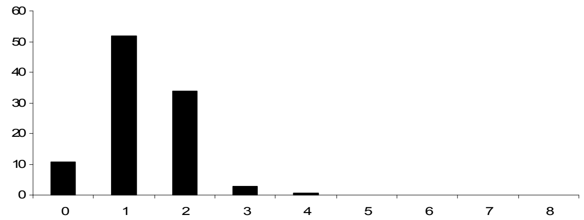
In front of the Bulgarian coast whiting catch length composition ranged between 50 and 230 mm and individual weight between 3.08–86.2 g. The highest percent belongs to the 115-120 mm group, followed by 135-140 mm and 155-160 mm. The length group 85-90 mm, accounts around 6% of the whiting by-catch. The rest of the length groups are very weakly presented in the landings (Maximov et al., 2009). The analysis performed by (Raykov et al., 2008), show that highest value for L asymptotic of the whiting was calculated in Ukrainian waters (39 cm) with the lowest growth rate (k = 0.106), accordingly. In Bulgarian and Romanian marine area the values are very similar and lower, as regards the asymptotic length (Table 6.3.1).

Table 6.3.1. Length growth of Whiting in the North-Western part of the Black Sea (Raykov *et al*., 2008)

Merlangius merlangus euxinus(Nordm)

$L_t = L\infty\ (1-e^{-k\ (t-t_0)})$	Age					
	1	2	3	4	5	6
Bulgaria $L_t = 29.83\ (1-e^{-0.157(t+2.49)})$	12.6	15.09	17.2	19.06	20.6	22.0
Romania $L_t = 26.3\ (1-e^{-0.16\ (t+2.19)})$	10.5	12.8	14.8	16.6	18.0	19.2
Ukraine $L_t = 39\ (1-e^{-0.106\ (t+1.324)})$	8.5	11.6	14.3	16.8	19.0	21.0

According tothe Romanianbiometric data from monthly sampledlandings2012, parameters of growth von Bertalanffy and length-weight relationship for whiting population in 2012are as: L_∞= 18.95 cm, K= 0.2958, t_0 = -1.1925; a= 0.10215273, b= 2.830571.
The analysis of age components during the entire fishing season 2012 emphasized the presence of individuals aged in Romanian waters between 0+ to 2;2+ years, in Bulgarian and Ukrainian waters between 0+ to 5;5+ years and for Turkish 0+ to 8;8+ year classes (Figure 6.3.4). Readingage ofwhitingcarried outfrom otoliths, judging by thedifferences inaverage weight-at-age in determining theageof fisholder than twoyears, there are largediscrepancies(Figure 6.3.5). Maybe itindicatedto the existenceof various localwhitingstocks.
In previous studies (Prodanov et al. 1997; Daskalov, 1998) an estimate of M = 0.7 has been applied over all age groups and year in VPA/XSA analyses. Natural mortality of the Black Sea whiting for the period of total absence of it fisheries in the waters of the former Soviet Union (1975-1977) was determined by three methods: Beverton-Holt M = Z = k (L ∞ - l') / (l'-l1) = 0.72; Robson-Chapman M = Z = ln (1 + t'-1 / n) - ln t '= 0.74 and Gulland M = Z = - (ln Nt +1 - ln Nt) = 0.73 (Shlyakhov, 1983).
1.



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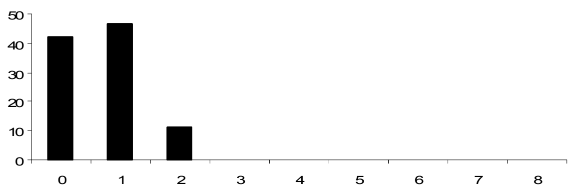

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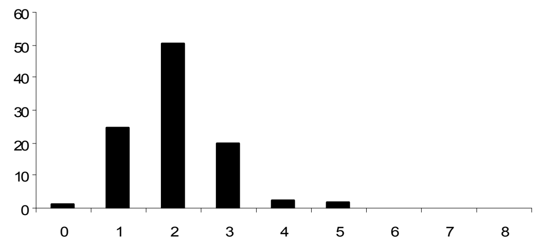

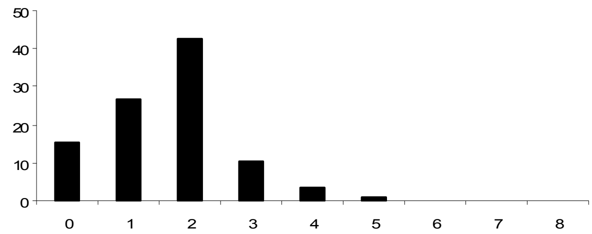

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Fig. 6.3.4.The age compositionof landingsWhitingBulgaria, Romania, Turkey and Ukraine in 2012

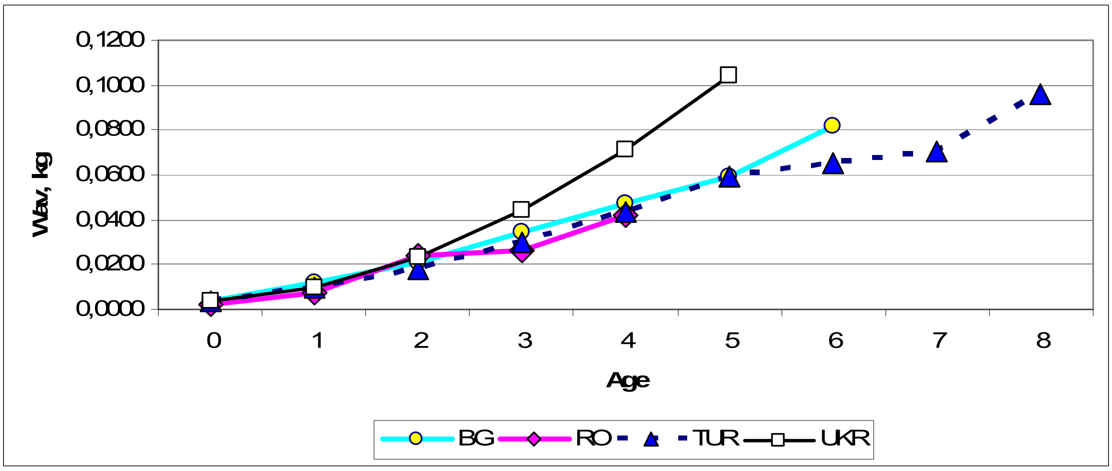


Fig. 6.3.5. The average weight ofWhitingby agein 2012

6.3.1.3 Maturity

In the population ofthe Black Seawhitingmaturationof malestakes place onthe first andsecond year of life, and that of females-after reach of age1 year (Svetovidov, 1964 Shlyakhov,1983).For the purposesof stock assessmentis commonly usedogivesmaturationof females. In previousassessmentsEWGtaken intoaccount the data ofRomania andUkraine inthe maturationof females: for ages0+- 0%, 1 - 75%, 2 and older -100% (Fig. 6.3.6). According to the materialsof RomanianandTurkish scientistsrateof maturationof femaleswhitingin 2012was slowerthan in previous years, so we were proposedtoclarifythe relevantstock assessment.

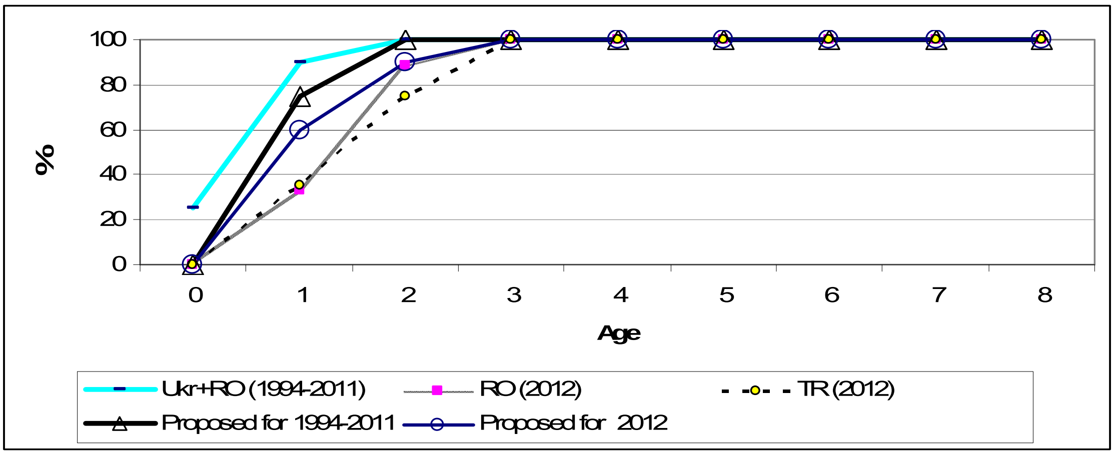


Fig. 6.3.6. Maturity proportion of the Black Sea Whiting in 1994-2012

6.3.2 *Fisheries*

6.3.2.1 General description

The general management criteria announced by General Directorate of Fisheries for 2012-2014 were as follows (Anonymous, 2012). The summary of whiting regulation is given Table 6.3.2.1.1.

(1)Area closures: The whiting fishery with bottom trawls is prohibited along waters a) between Sinop city, İnceburun (42° 05.959’ N-34° 56.695’ E) and Samsun city, Yakakent, Çayağzı Cape (41° 41.040’ N-35° 25.193’ E), b) between Ordu city, Unye; Taskana Cape (41° 08.725’ N-37° 17.531’ E) and Georgia border, c) between Ereğli Baba Cape (41° 17.342’ N-31° 23.937’ E) and Bartın city, Amasra, Tekke Cape (41° 43.485' N-32° 19.258' E) in 2 miles from land. Furthermore, in open areas it is prohibited to make any fishery within 3 miles from land (Fig. 6.3.2.1.1).

(2) Time closures: In open areas, the whiting fishery is prohibited between 15 April-15 September.

(3) Mesh size limitations: The mesh size should not be lower than 40 mm.

(4) Minimum legal catch size: For all kind of fisheries minimum legal size (total length) is 13 cm.

Table 6.3.2.1.1. The current recommended of parameters for fisheries regulation on the whiting stocks along the Turkish Black Sea

Regional area	Official mesh size for bottom trawl	Legal landing size (TL)	First maturation size (TL50%)	Scientifically recommended minimum catch length (cm)	Scientifically recommended mesh size for bottom trawl
Southern Black sea coasts (Turkey)	40 mm	13.0 cm	14.5 cm	15.0 cm	44 mm

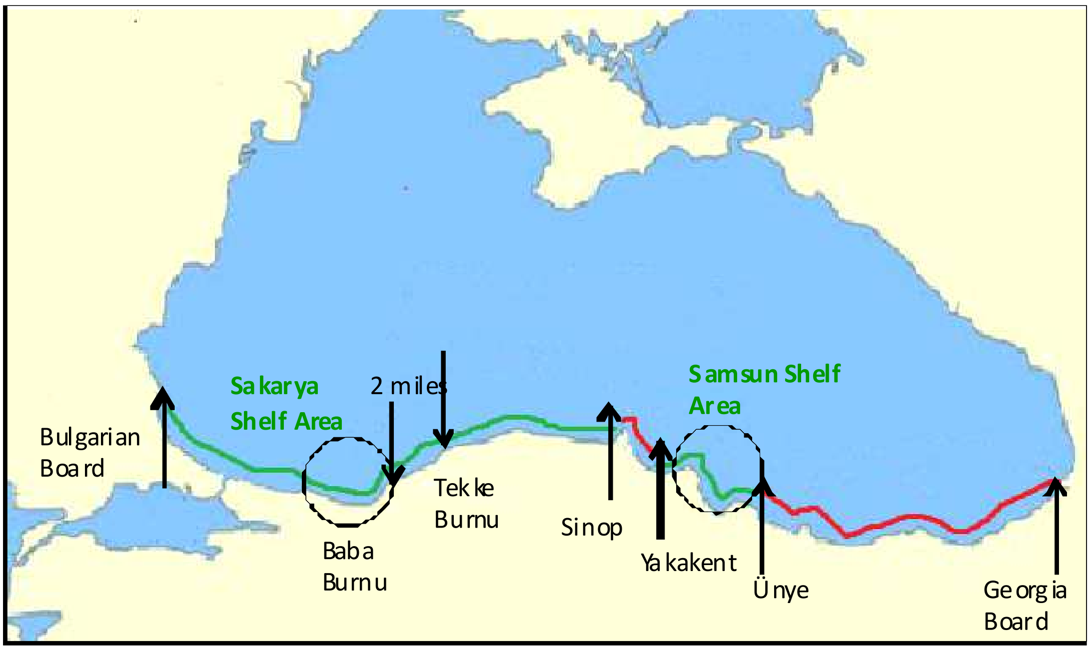


Fig. 6.3.2.1.1. Area closures and limitations for distance from land for bottom trawling along Turkish coasts (Green lines: open areas, red lines: area closures)

The whiting fishing fleet grew significantly after 1990 also targeting other demersal fishes in the habitat. The number of bottom trawl vessels is not constant as they can also operate as mid-trawl vessels by changing gear equipment depending on actual fish movements and follow the schools of pelagic species. Depending on official records there are over a hundred of bottom trawls operating in Samsun Shelf Area at present.

There is no limitation in mesh size for gill net fishery of whiting but the fishermen generally use the gears with 32 mm mesh size. However, by the decrease in mean individual size in recent years, they also started to use nets with 28 mm mesh size. In relation with the decrease inlandings of whiting in the last three decades, a clear negative gradient was determined in mesh size of gill nets with ten year intervals (Zengin, 2012) (Fig.6.3.2.1.2).

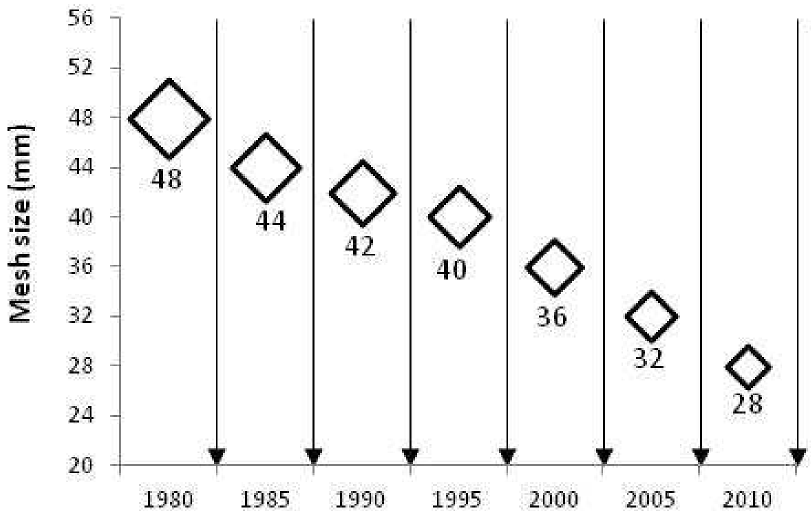


Fig. 6.3.2.1.2. The change in mesh size of gill nets used in Whiting fishery in the last three decades (Zengin, 2012).

Until 2000, whiting nets were produced with monofilament fishing strings (transparent). By the ruling of General Directorate of Fisheries in 2010, the use of monofilament strings was prohibited. A period of one year was allowed for the alteration of nets to multifilament (synthetic) nets. This period ended with September, 2011. To replace monofilaments with multifilament creates an economic pressure on fishermen. By this prohibition, it is aimed to reduce the fishing pressure on whiting population, because of; (1) the catchability of monofilaments is higher than multifilament nets. (2) Monofilaments can easily fall into ruin, sink into bottom and cause '*ghost fishing*' (Ayaz et al., 2006; STECF, 2011).

Selectivity studies about gillnets were carried out with different queries. Aydın (1997) investigated the selectivity of different mesh sizes, any significant effect of net colour and twine number. The author concluded that optimum lengths of whiting caught by 40 and 44 mm mesh sized nets were as 17.28 cm and 19.01cm and determined no effect of net colour in selectivity but a significant higher effect by twine No:0 versus No:1. Dinçer et al., (2005) tested the effect of different parameters in long lines and estimated an average value of CPUE as 0.31 kg/hourin four different trials. Özdemir and Erdem (2006) concluded that gillnets and multifilament nets are more selective in whiting fishery than trammel nets and monofilaments. Öztaş and Balık (2012) investigated the efficiency of gillnets with 32, 34, and 36 mm mesh sizes and estimated CPUE values in three different coastal areas on a seasonal base for whiting fishery. The authors determined significant differences between locations and recorded the highest CPUE values in fall for all locations.

The mesh size of bottom trawls codend is designed to catch whiting and red mullet as 40 mm to catch whiting. Studies on selectivity of bottom trawls along Turkish coasts reveal that the most proper mesh size is 44 mm for whiting population. In a selectivity study to compare the efficiency of square and diamond mesh size, Zengin et al. (1997) presented the values of L_{50} as 13.1, 14.8 and 15.0 cm obtained by diamond mesh size of 36, 40 and 44 mm, respectively. L_{50} of whiting was determined as 16.2 cm for square mesh size of 44 mm in the same study. Aydın et al., (1998) emphasized the selection factor for square mesh cod-end were higher than those for diamond mesh cod-end. The authors displayed that L_{50} were found to be 13.1, 14.8, 15.1 cm for 36, 40, 44 mm diamond mesh sizes, respectively and 16.1 cm for 22 mm square mesh size. Another research recorded optimum catch size as 14.3 cm for the mesh size of 44 mm (Özdemir, 2006). Genç et al, (2002) determined L_{50} for whiting as 13.54 for the cod end size of 40 mm. The respective L_{50} lengths for the cod end sizes of 36, 40, 44 mm those were used in gill nets were determined as 15.11, 16.79 and 18.47 cm. The minimum catch length should be set as 15 cm to let the individuals spawn at least once in a lifetime to support the sustainability of whiting population.

The selectivity studies gain more importance especially from the viewpoint of legislators while making decisions.The European Commission in their report to the European Parliament and the Council on the implementation of Article 9.3 of Council Regulation (EC) No 1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea advised for towed nets that:

'(9.3.)*from 1 July 2008, the net referred to in point 1 shall be replaced by a square-meshed net of 40 mm at the cod-end or, at the duly justified request of the ship-owner, by a diamond meshed net of 50 mm.'*

In 2011, in the framework of the implementation of a recommendation by the General Fisheries Commission for the Mediterranean, the European Parliament and the Council adopted the following amendment replacing the Article 9.3 as:

(1) For towed nets, other than those referred to in paragraph 4, the minimum mesh size shall be at least:

(a) a square-meshed net of 40 mm at the cod-end; or

(b) *at the duly justified request of the ship owner, a diamond-meshed net of 50 mm of an acknowledged size selectivity that is equivalent to or higher than that of nets referred to under point (a)* (European Commission, 2012).

"Regulations of the Commercial Fisheries in the Black Sea Basin" currently in force in Ukraine have determined the following requirements: minimum commercial size of whiting – 12 cm (SL); the allowable by-catch of its juveniles – not more than 20% of total biomass of catch during non-target trawl fisheries and not more 30% by counting during the target fisheries with trawls (with mesh size not less than 12 mm).

Up to2012 the annual regulation of whiting fisheries includes determination of the limits for whiting harvesting on the basis of its stock value and TAC. It should be noted, that even taking into account the by-catch in sprat fisheries total yield of whiting in the Ukrainian waters does not exceed 30% of TAC. In accordancethe Law of Ukraine№ 3677-VI (adopted in June 2011)valueof catchof marine biologicalresources are notlimitedif it can notbe reachedexploitation levelthat threatensthe stateof stocks(due to the nature of their spatial distribution, or because of the limitedtechnical capabilities offishing). TACswhitinginUkrainianwatersfar exceedsthe technicalcapacity of the nationalfishing fleet.For example, in 2012, the TACwas equal to8900tons and the projected actualcatch wasless than 40tons.Therefore,since2013forwhitinglimitis not set.

6.3.2.2 Catches

6.3.2.2.1*Landings*

The following table lists the whiting landings 1980-2012 (Table 6.3.2.2.1.1). Remarkable decrease occurred in Turkish landings of whiting caught by bottom trawls in recent two decades and the decrease seems on-going. The main reasons may be the illegal fishery by infringements of time and area, mesh size applications and increase in fishing effort. The mean length of landed catch for long years is another evidence of the exhaustion in whiting population. The mean total length for whiting decreased from 19.7 cm to 8.9 cm and the landings from 16.3 to 8.1 thousand tons from 1990 to 2011 (Fig. 6.3.2.2.1.1).

Table 6.3.2.2.1.1. Whiting landings (tons) by countries (FAO Fisheries Statistics, GFCM Capture Production 1980 – 2008, 2009 – 2012 from National Fisheries Statistics of countries)

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Former USSR
1970	-	.	115	.	4312	.	.

1971	-	.	442	.	5855	.	.
1972	-	.	416	.	5284	.	.
1973	-	.	329	.	2476	.	.
1974	-	.	1305	.	2844	.	.
1975	454	.	346	.	3913	.	.
1976	347	.	541	.	4213	.	.
1977	218	.	1495	.	5726	.	.
1978	407	.	1345	.	21265	.	531
1979	71	.	1205	.	20778	.	11377
1980	30,0	.	618,0	.	6838,0	1102,0	2690,0
1981	1,0	.	894,0	.	4669,0	2083,0	2238,0
1982	4,0	.	800,0	.	4264,0	825,0	1513,0
1983	0,0	.	1080,0	.	11696,0	817,0	2381,0
1984	0,0	.	1192,0	.	11595,0	2252,0	4738,0
1985	0,0	.	3138,0	.	16036,0	1101,0	2655,0
1986	0,0	.	1949,0	.	17738,0	1867,0	2652,0
1987	0,0	.	615,0	.	27103,0	579,0	2764,0
1988	0,0	5,0	1009,0	736,0	28263,0	1482,0	2223,0
1989	0,0	5,0	2739,0	7,0	19283,0	584,0	-
1990	0,0	0,0	2653,0	235,0	16259,0	87,0	-
1991	0,0	0,0	59,0	210,0	18956,0	24,0	-
1992	0,0	70,0	1357,0	37,0	17923,0	0,0	-
1993	0,0	172,0	599,0	16,0	17844,0	4,0	-
1994	0,0	187,0	432,0	125,0	15084,0	64,0	-
1995	0,0	146,0	327,0	91,0	17562,0	17,0	-
1996	0,0	223,0	389,0	11,0	20326,0	3,0	-
1997	0,0	58,0	441,0	10,0	12725,0	29,0	-
1998	0,0	53,0	640,0	119,0	11863,0	55,0	-
1999	0,0	41,0	272,4	184,0	12459,0	18,0	-
2000	9,0	36,5	275,0	341,0	15343,0	20,0	-
2001	8,0	32,0	306,0	642,0	7781,0	18,0	-
2002	16,0	37,0	85,0	656,0	7775,0	9,0	-
2003	13,0	45,0	113,4	93,0	7062,0	21,0	-
2004	2,0	29,0	117,6	55,0	7243,0	43,0	-
2005	3,0	30,0	93,3	78,0	6637,0	30,0	-
2006	2,0	37,0	96,7	60,0	7797,0	15,0	-
2007	16,1	41,0	17,1	22,0	11232,0	64,0	-
2008	0,4	15,0	55,2	96,0	10986,0	9,0	-
2009	2,3	15,0	39,5	52,0	8979,0	17,0	-
2010	14,7	15,0	23,6	23,0	11894,0	17,0	-
2011	1,0	42,0	0,1	20,9	8122,0	36,0	-
2012	1,4	42,0	0,4	2,8	6251,4	34,0	-

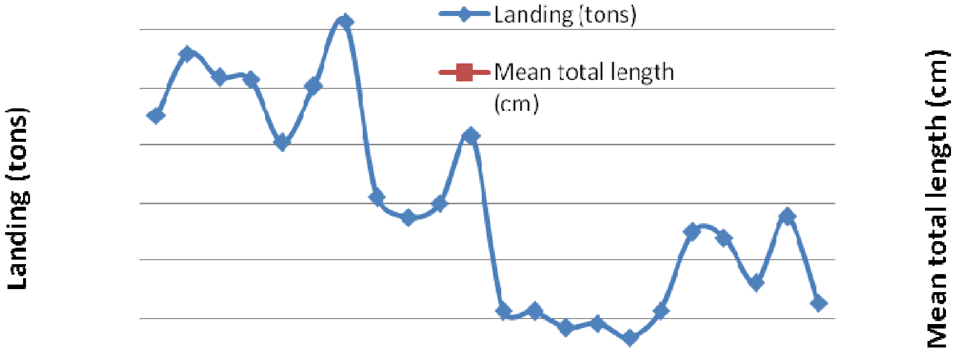


Fig. 6.3.2.2.1.1. The general trend in the landings and the mean total length of Whiting population along Turkish Black Sea coasts in recent two decades (Zengin, 2012).
Landings/catches of Whiting after removal of age class 0 and 1 from the data are summarized in Figure 6.3.9.b.

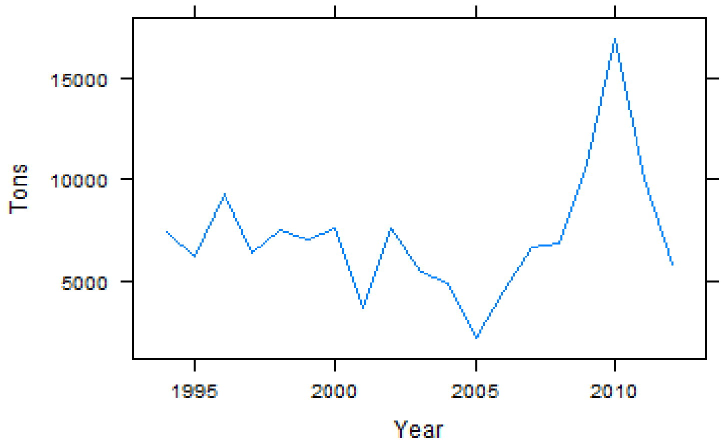


Fig. 6.3.2.2.1.2.Landings/catches of Whiting in the Black Sea after removal of age class 0 and 1 from the data.

6.3.2.2.2*Discards*

Since the mid-1970s to the early1990sin the waters ofBulgaria and theformer USSRstudies to assess by-catchwhitingin the trawl fisherysprat were performed (Prodanov et al, 1997). Part of by-catchis discarded into thesea, andthe restlabeled like "sprat" (fractionof spratin suchlandingsare usuallyexceed90-95%). In anycase,whitingfishedalmostdid not get infishingstatistics.Although some of thewhitingfisheryin thespratfellto the shore (under the guise of sprat), it couldonly formallyconsideredby-catch, and in fact acted as a "discard" furtherwe use the termdiscard holderwithout the quotes, but with the explanationmade. In thesestudies, nosamplingwas doneto determine discard forages, but it was knownthat the seais thrownmainlywhitingagedless than twoyears. In the waters ofBulgaria in1976-1987 discard whitingwas the largestand annuallyexceed1,000 tons, maximum – 3860 tons(Table 6.3.2.2.2.1).In the absence ofofficiallandings ofwhitingin1982-1993, discardwas 100%.

Table 6.3.2.2.2.1 Dynamics of the discard Whiting(by-catch discarded into the sea plus landed whiting under the guise of sprat)in trawl fisheriesspratBulgaria andformer USSRin the BlackSeain1975-1993

Year	Bulgaria		Ukraine	
	Discard, tons	Discard, %*	Discard, tons	Discard, %*
1975	300	39,8	N.A.	N.A.

1976	1338	78,0	85	79,5
1977	1917	89,8	800	100,0
1978	2506	86,0	2700	82,2
1979	2493	97,2	6500	36,4
1980	3860	99,2	2780	50,5
1981	2563	100,0	3970	61,1
1982	2750	100,0	6686	81,5
1983	1507	100,0	5419	69,5
1984	1711	100,0	5741	54,7
1985	1501	100,0	2316	46,3
1986	1118	100,0	2140	44,6
1987	1058	100,0	1736	38,6
1988	886	100,0	2277	50,6
1989	745	100,0	5409	90,2
1990	359	100,0	8478	96,3
1991	246	100,0	2576	99,1
1992	483	100,0	900	100,0
1993	620	100,0	500	100,0

* was calculatedas the percentageof discardof the amount ofofficial landing Whiting and discard

In Ukrainian waters the largest by-catch and discard whitingwas in 1978-1991 (1.7-6.7 thousand tons annually). Sampling whiting bycatch-at-sea during 1992-2002 in water Ukraine was conducted (Shlyakhov, Charova, 2006). These estimates are based on the monitoring data extracted in the process of sprat fisheries on board fishing vessels. In Ukrainian waters target fisheries for whiting and sprat with midwater trawls are permitted approximately at 60% of the shelf zone. As sprat trawl fisheries are more profitable for economic reasons, fishermen try to conduct fisheries on the grounds with its densest concentrations, occurring usually in depth range 30-60 m and less. Between1990-1994and2005-2009occurredUkrainianmovementtowards thetrawlfishery inshallow coastal waters(Shlyakhov, Shlyakhova, 2011). This process isaccompanied by an increasein thediscardwhitingage0+ and 1with respectto total landings (Table 6.3.5). The average forthe period1994-2002relative value ofUkrainian“discard”in the totalthe Black Sea countries catch ofwhitingfor different agesvariedfrom 2.2%to 12.5% (Figure 6.3.10).

Table 6.3.4. Dynamics of the discard Whiting(by-catch discarded into the sea plus landed whiting under the guise of sprat)in trawl fisheriesspratBulgaria andformer USSRin the BlackSeain1975-1993

Year	Romania		Ukraine	
	Discard, tons	Discard, %	"Discard", tons	"Discard", %
1994	N.A.	N.A.	336	84,0
1995	N.A.	N.A.	583	97,2
1996	N.A.	N.A.	1097	99,7
1997	N.A.	N.A.	971	97,1
1998	N.A.	N.A.	945	94,5
1999	N.A.	N.A.	632	97,2
2000	N.A.	N.A.	930	97,9
2001	N.A.	N.A.	982	98,2
2002	N.A.	N.A.	1791	99,5
2003-2010	N.A.	N.A.	N.A.	N.A.
2011	0,1	99,6	N.A.	N.A.
2012	0,4	97,3	N.A.	N.A.

Table 6.3.5. Percentage discard rate of the Black Sea Whiting by age class and year in 1994-2012 (1994-2002 – data from midwater trawl sprat fishery for Ukrainian waters, 2011-2012 – data from pound nets fishery for Romanian waters, 2003-2010– data not available)

AGE	0	1	2	3	4	5	6
1994	3.13	1.00	1.64	0.07	0.69	10.61	100.00
1995	4.08	1.57	7.73	0.98	2.21	0.64	1.58
1996	7.88	2.58	2.16	2.38	3.63	6.10	5.12
1997	7.74	7.58	2.66	2.70	35.47	93.84	100.00
1998	20.53	5.60	5.60	5.60	5.60	5.60	46.57
1999	14.61	4.36	3.35	3.27	3.33	4.28	58.13
2000	31.17	3.03	3.03	4.13	1.76	3.96	1.37
2001	18.20	12.43	4.09	4.09	5.55	2.39	3.36
2002	88.68	43.80	15.37	3.01	0.98	0.52	0.41
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	1.22	0.78	0.43	0.18	0.29	0.04	0.00
2012	37.10	3.04	0.38	0.00	0.00	0.00	0.00

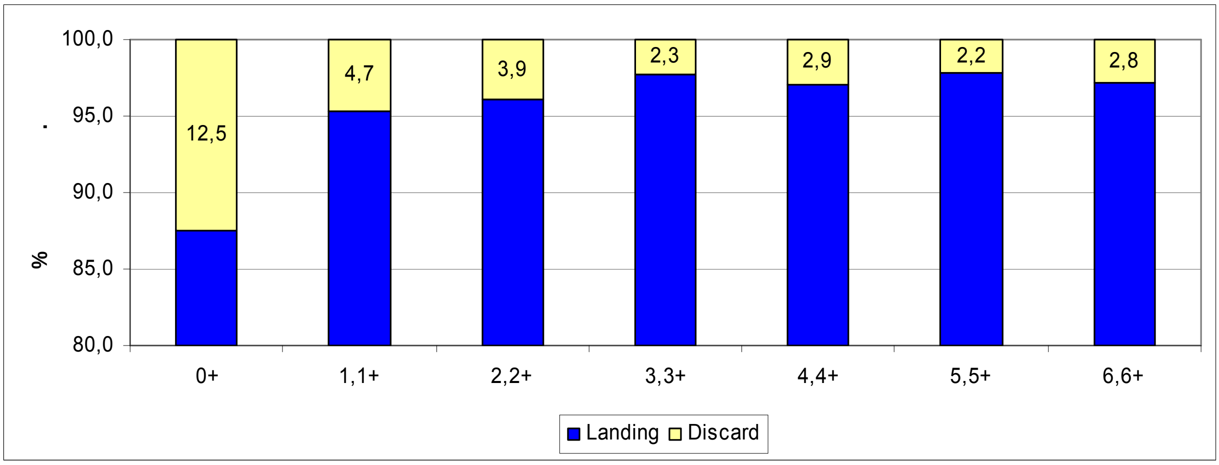


Fig. 6.3.10. Ukrainiandiscardin the total the Black Sea countries catch of Whiting the average for theperiod1994-2002 (withoutdiscardsin the waters ofotherBlack Sea countries)
2.

In Turkish waters (Samsun shelf area) the rate of whiting landing (marketed fish) and discards observed in 2005-2011 in experimental surveys and commercial vessels were pointing out the heavy exploitation. In accordance with data obtainedtheaverage discard valueindifferentfishing seasonsrangedbetween30% and 50% (Fig. 6.3.11)for age class 0 and 1 (Zengin et al.,2011).

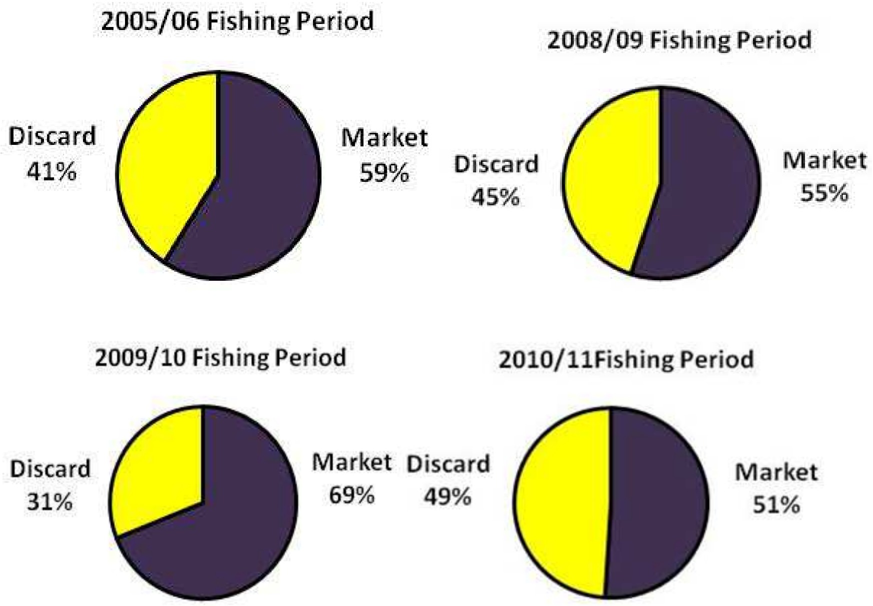


Fig. 6.3.11. The composition of marketed and discard Whiting as a biomass in Samsun shelf area

In 2013,for the first timewere presented to the EWG theBulgarian(1975-1993) andUkrainian(1976-2002) data of discardwhiting on trawl fishery of sprat, the Turkish (2005-2011) and Romanian(2011-2012)data of discardforthe targetwhitingfishery. Thesedata show that a discard is an importantpart of thewhitingcatchesin ages0+and 1, and thereforetheyshould be included inthe data setto stock assessment. But it isimpossibleto makebecause of incompletedata fordiscardby agein1994-2002and2011-2012, and the total absencein2003-2010.

6.3.2.3 Fishing effort

Information on fishing effort was not provided.

6.3.2.4 Commercial CPUE

The mean catches per unit effort (CPUE) and abundance index (CPUA) are estimated respectively as 31.03 kg/km^2 and 64.73 kg/km^2 (Table 6.3.2.4.1). Trawl samplings conducted is generally below of 40 m (minimum 24.7 m, maximum 113.0 m) depths along in the SSA and WBS littorals zones. The stock is localized under the thermocline layer which is started about 40 m. The surveys period is included 7 months (from January to April and from September). Abundance indices were estimated by ‘swept area method’ for the period of sprat fishing seasons (January-May) from commercial vessels (Sparre and Venema, 1992). It is also given biomass indices of pooled data by mapping two parts of Turkish Black Sea (Figure 6.3.2.4.1a and b).

Table 6.3.2.4.1. Descriptive data regarding (kg/h) and abundance indices (kg/km^2) of whiting for 2011 and 2012 in the Samsun shelf area (SSA) and West Turkish Black Sea

Region	No of hauls	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CPUE/GENERAL	102	0.00	150.00	31.03	2.72	27.46
CPUA/GENERAL	102	0.00	387.10	64.73	6.59	66.60
CPUE/SSA (EBS)	60	0.00	150.00	30.59	3.64	28.20
CPUE/ WBS	42	0.00	100.00	31.66	4.12	26.69
CPUA/ SSA (EBS)	60	0.00	387.10	62.91	8.98	69.55

CPUA/WBS	42	0.00	232.40	67.35	9.70	62.87

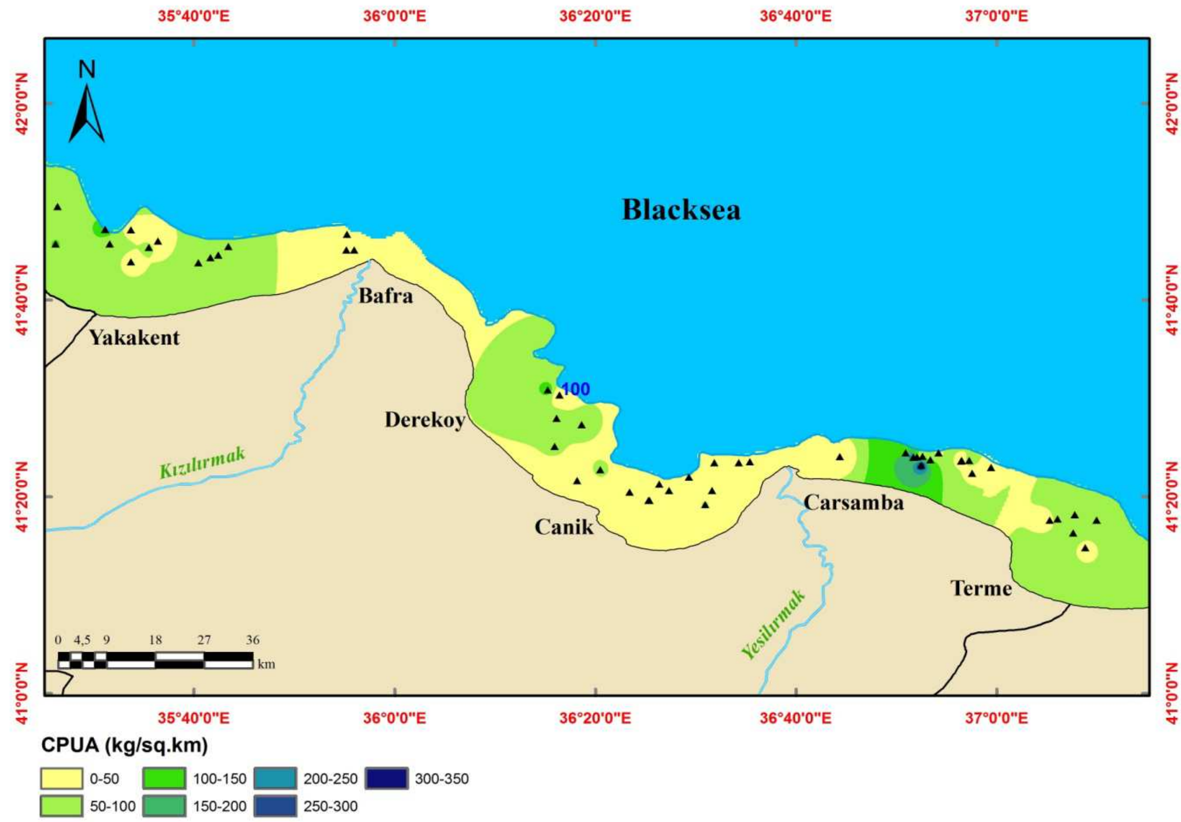


Figure 6.3.2.4.1a.Map of biomass indices in the Samsun Shelf Area, 2012 (This mapping is coverage all data).

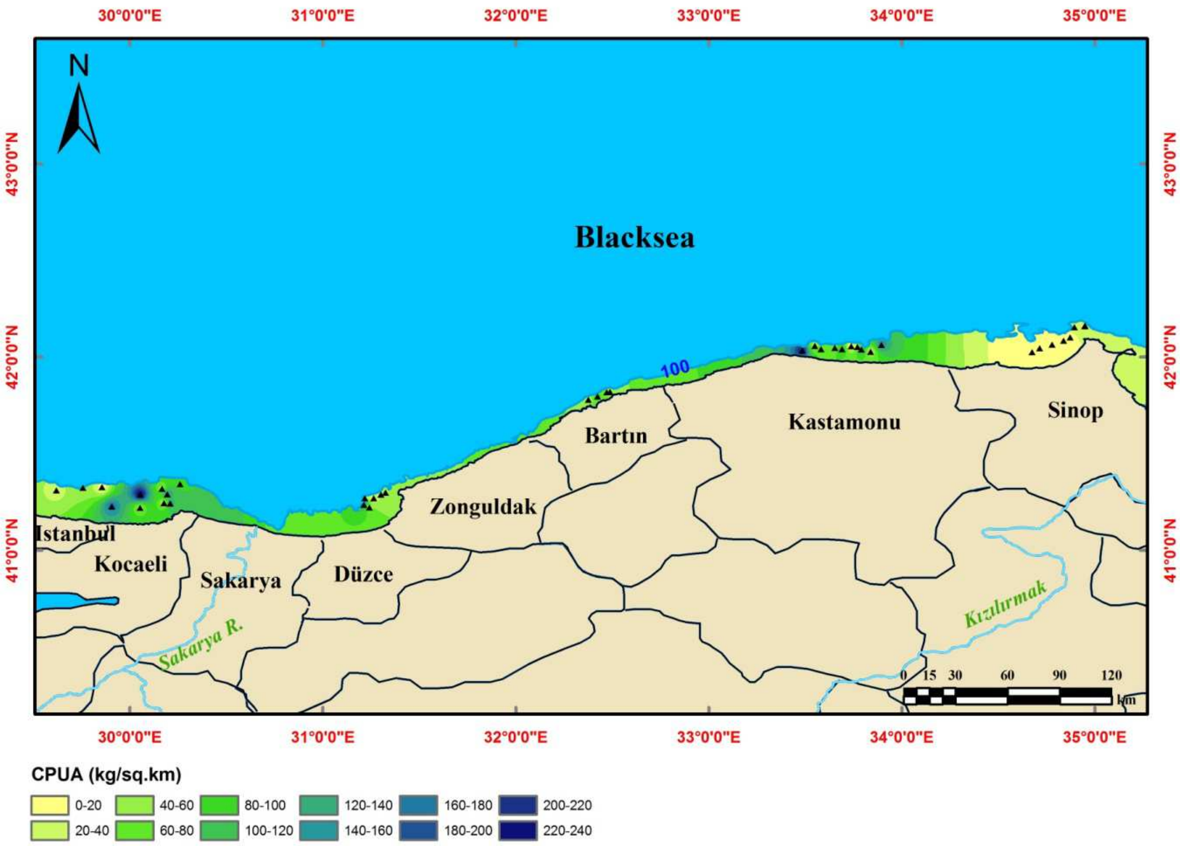


Figure 6.3.2.4.1b.Map of biomass indices in the West Black Sea Turkish Region , 2012 (This mapping is coverage all data).

The monthly distribution of CPUE and landings with bottom trawls in whiting fishery for the southern coast of Black Sea in 2011 was represented in Figure 6.3.2.4.2. The CPUE values seem to be higher for Samsun shelf area (mean 213.2 kg/vessel/day) than the western coast (159.3 kg/vessel/day). It is known that Samsun shelf is wider and more productive when compared to the western coasts. This impels the bottom trawl fishery in the region and the number of vessels in the fleet increased in Samsun (Gümüş and Zengin, 2012).

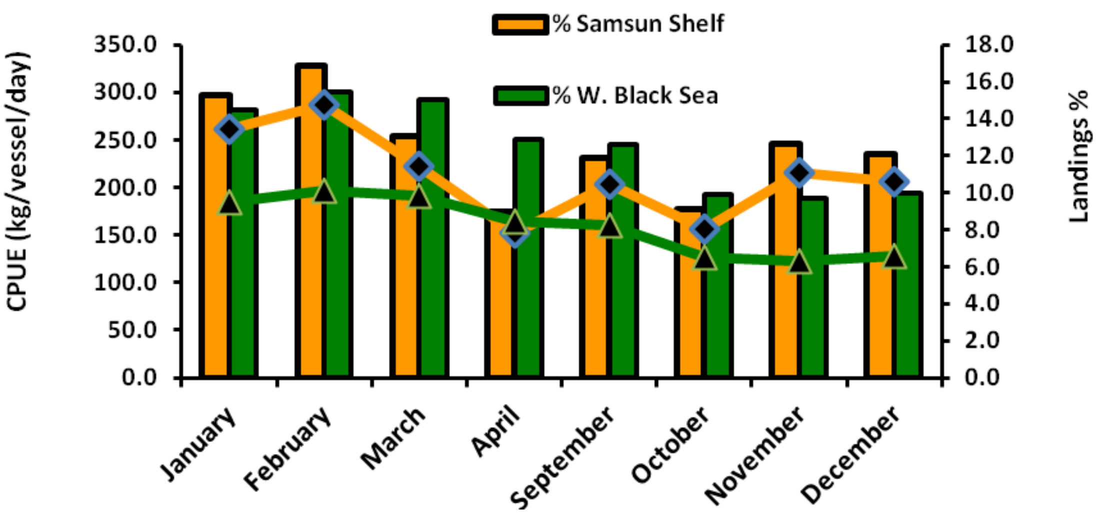


Figure 6.3.2.4.2. The distribution of CPUE and landings in 2011 for Samsun Shelf and the western Black Sea coast in Whiting fishery (Zengin et al., 2011)

In accordancewith the TurkishresearchCPUEfishing vesselstrawlingforwhiting by agein 2009-2012havea clearly pronounced negative trend, except for the5-year-old fish (Table 6.3.2.4.2).

Table 6.3.2.4.2. CPUE forWhiting by ageaccording toTurkishsurveysof the fishing fleet (trawls)

Year	Country	Age									TOTAL
		0	1	2	3	4	5	6	7	8	
		kg/h									
2009	Turkey	116,1	26,6	50,2	15,7	3,6	0,4	0,0	0,0	0,0	212,7
2010		0,4	12,9	19,6	6,2	1,3	0,2	0,0	0,0	0,0	40,7
2011		2,8	18,5	20,6	8,5	1,2	0,6	0,0	0,0	0,0	52,1
2012		0,3	7,7	15,6	6,1	0,8	0,5	0,1	0,0	0,0	31,0
N/h											
2009	Turkey	17131,3	3922,0	7404,8	2321,8	533,4	62,8	0,0	0,0	0,0	31376,1
2010		32,0	1130,1	1711,9	544,4	117,0	20,6	0,0	0,0	0,0	3556,1
2011		256,5	1697,1	1890,8	780,8	110,8	58,9	0,0	0,0	0,0	4794,9
2012		26,9	615,2	1244,1	483,8	62,2	39,1	4,2	0,5	0,9	2476,8
$N \times 10^{-6}$											
2008	Romania	36	523	218	23	0	0	0	0	0	800
2009		90	434	258	54	0	0	0	0	0	837
2010		149	524	195	22	0	0	0	0	0	890
2011		119	479	226	38	0	0	0	0	0	863
2012		232	256	63	0	0	0	0	0	0	551

6.3.3 *Sceintific surveys*

6.3.3.1 Scientific Trawl Surveys

6.3.3.1.1*Geographical distribution patterns*

Geographical distribution patterns of whiting in Romanian and Turkish waters of the Black Sea in 2012 are given in figures 6.3.13 to 6.3.16.

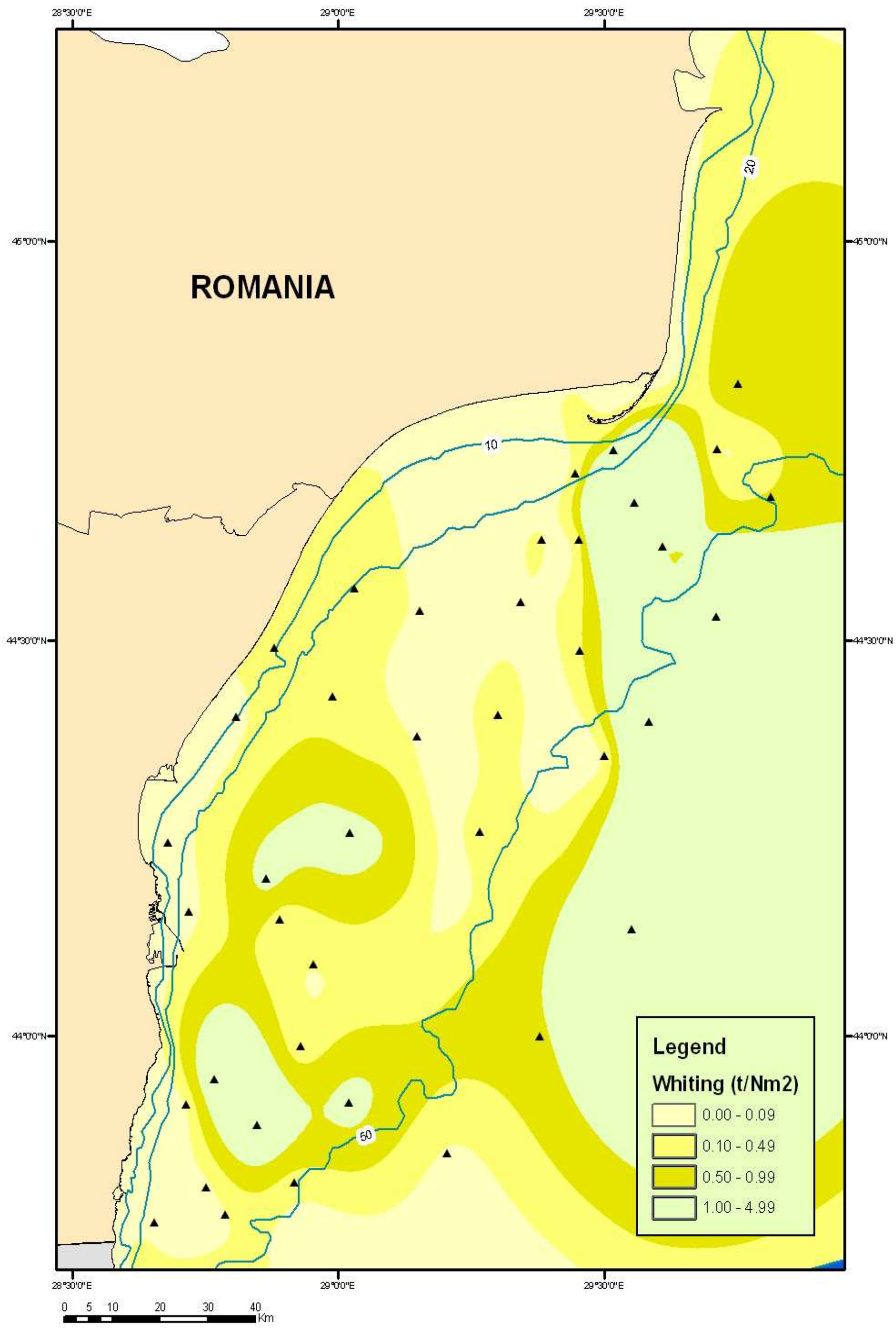


Fig. 6.3.13. Distribution of the Whiting agglomerations at Romanian littoral in spring 2012

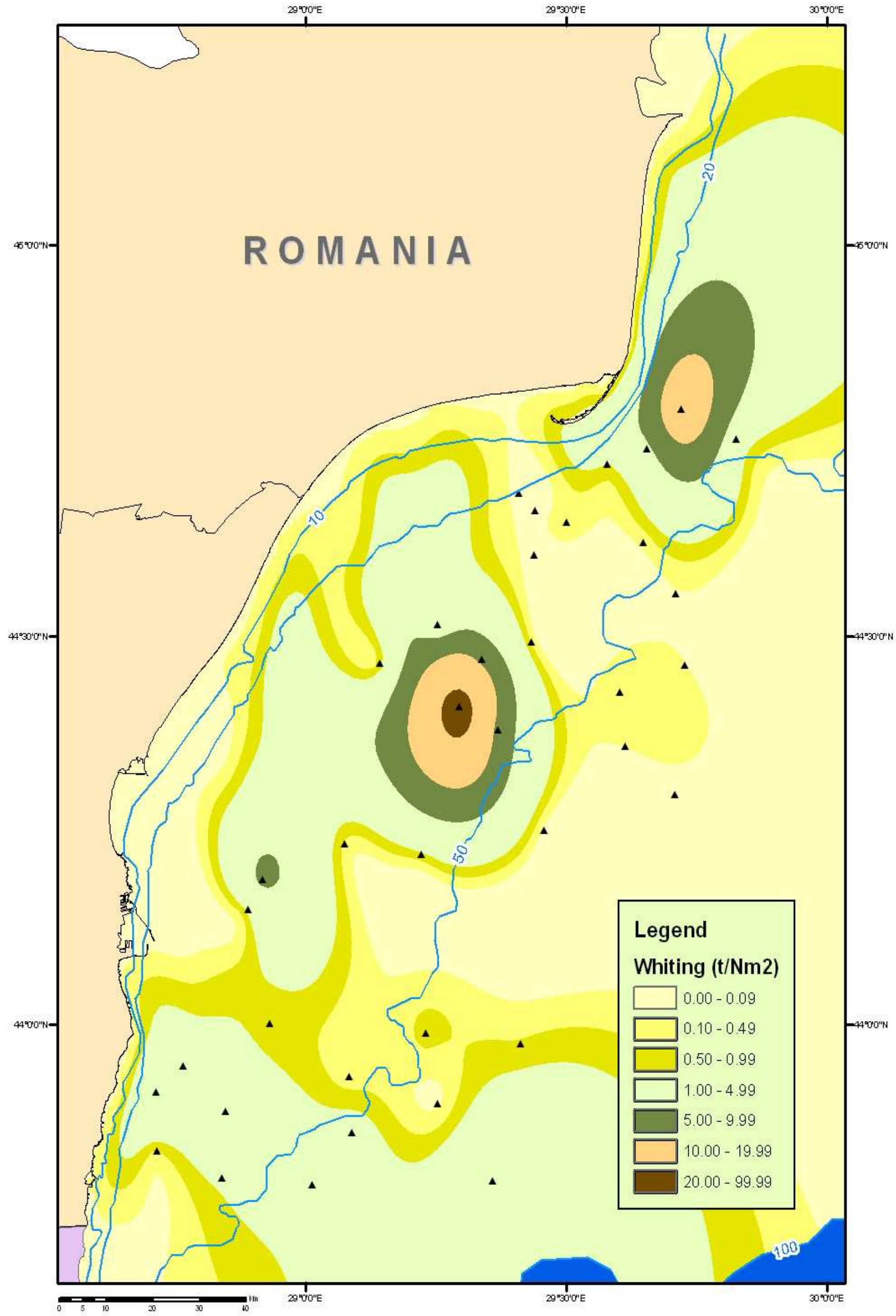


Fig. 6.3.14. Distribution of the Whiting agglomerations at Romanian littoral in autumn 2012

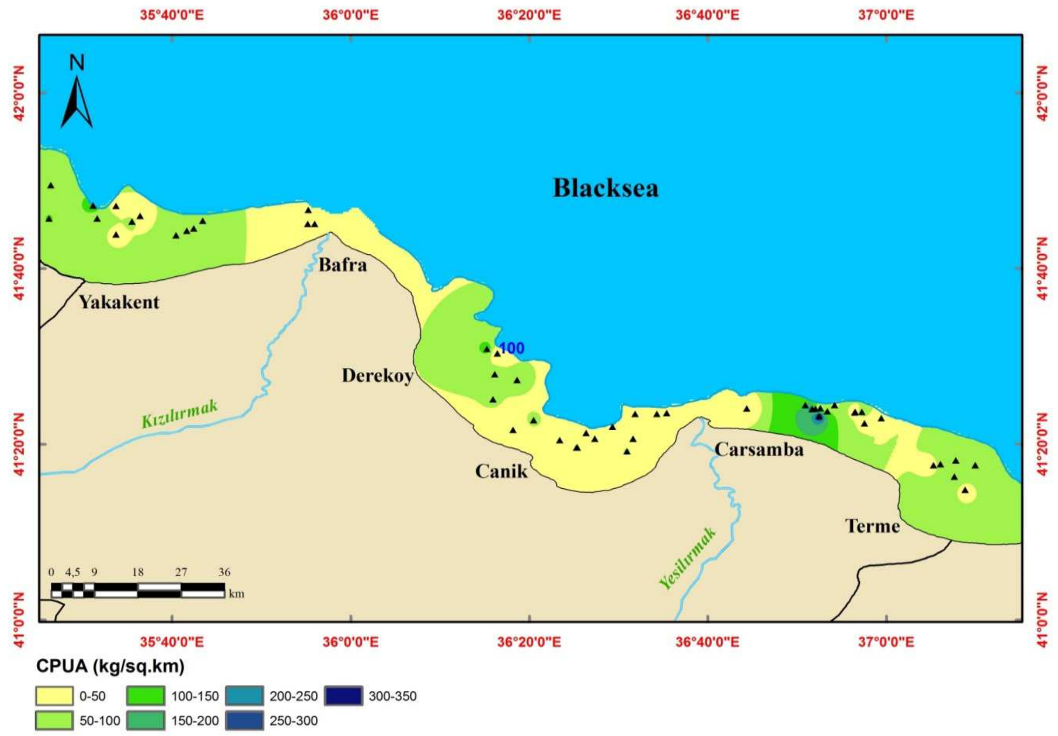


Fig. 6.3.15. Distribution of the Whiting agglomerations and it biomass indices along Eastern Black Sea coasts of Turkey in the Samsun Shelf Area (SSA), 2012

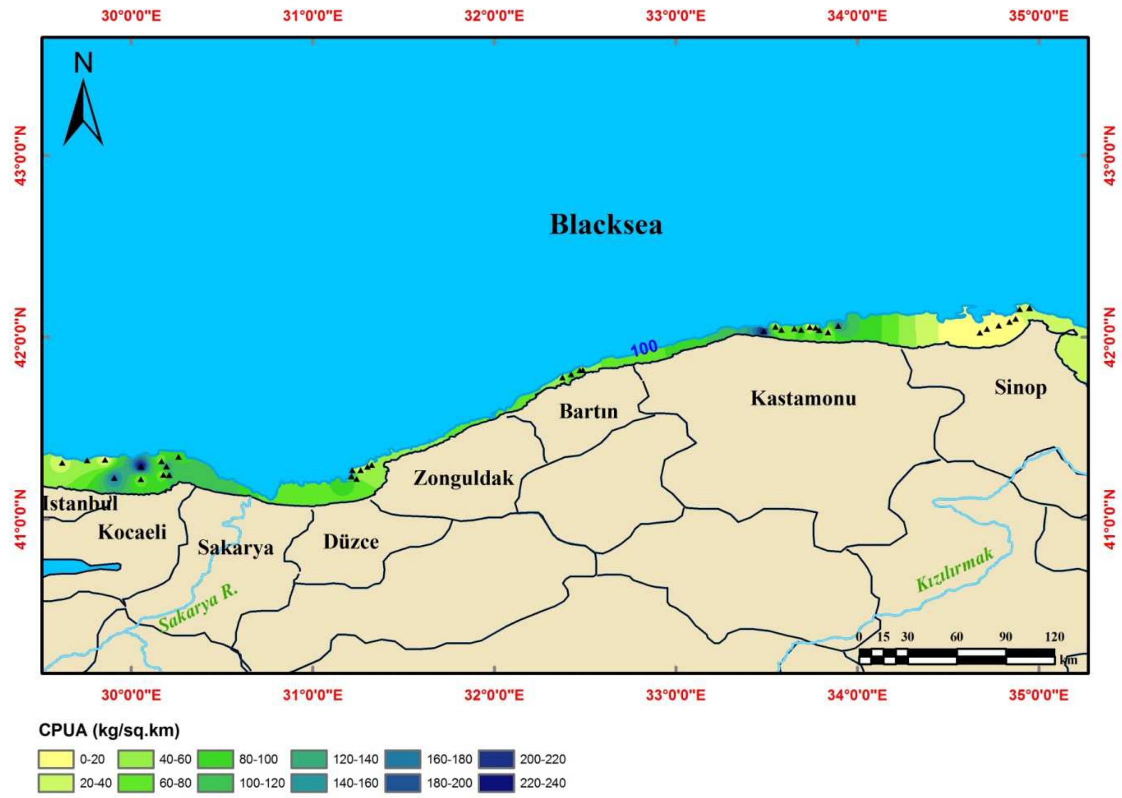


Fig. 6.3.15. Distribution of the Whiting agglomerations and it biomass indices in the West Black Sea (WBS) Turkish Region , 2012.

6.3.3.1.2*Abundance and biomass*

In Romanian waters the swept area method was applied for stock assessment of whiting. Results for estimated whiting biomasses and abundance in spring and autumn of 2012 in Romanian waters are given in Tables 6.3.7-6.3.8.

Table 6.3.7. Assessment of whiting agglomeration in the Romanian area in spring and autumn 2012, sampling gear bottom trawl 22/27-34 with horizontal opening of 13m

No	Season	No. stations	The depth range, m	kg/trawl	t/Mm²
1	Spring	40	12-60	13,365	0,762
2	Autumn	38	25-65	36,066	2,137

In 2012 the whiting population at the Romanian coast was homogeneous, length range between 60-180 mm, the dominant classes being 95-120 mm (fig 6.3.16). Analysis of the age composition of the entire fishing season revealed the occurrence of 0;0+ to 3,3+ years, with a dominance of individuals of 1;1+ years.

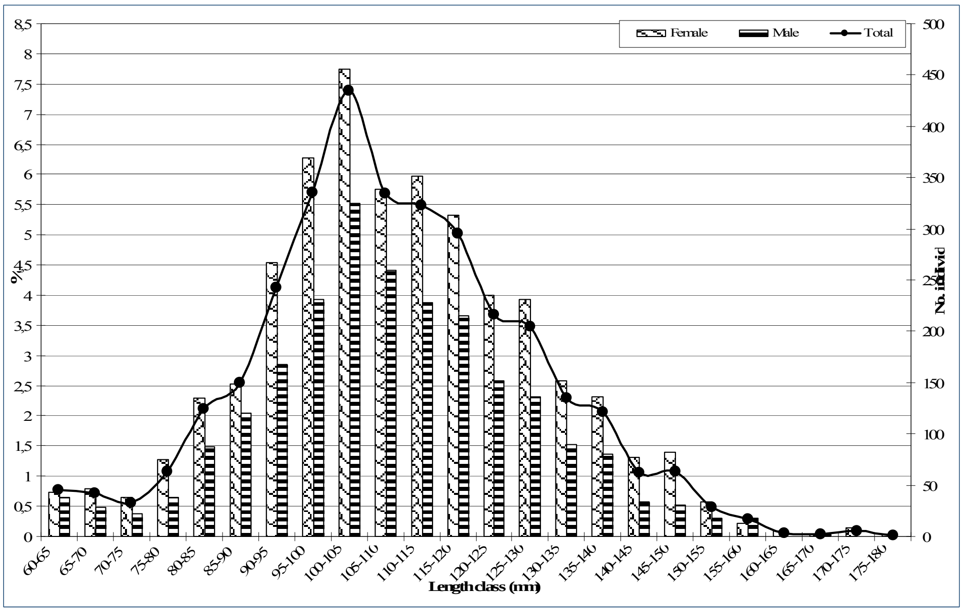


Fig. 6.3.16.Size structure of whiting catches, during 2012

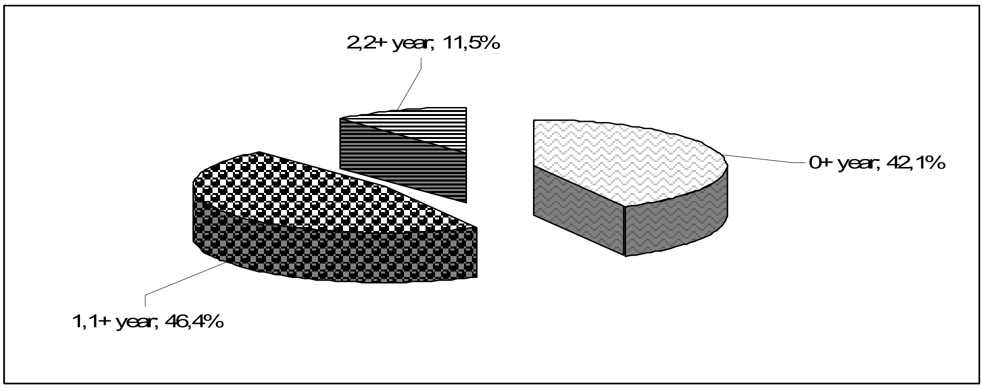


Fig. 6.3.17 Age compositions of whiting in 2012, Romania

Table 6.3.8. Indices ofabundance ofwhitingaccording to theRomanianresearchtrawl surveysin2008-2012 (N×10-6)

Year	0+	1,1+	2,2+	3,3+	TOTAL
2008	35,84	523,36	217,76	23,04	800,00
2009	90,19	434,18	257,72	54,49	836,57
2010	148,77	523,89	195,21	21,69	889,56
2011	119,47	479,04	226,47	38,09	863,06
2012	232,26	255,72	63,34	0,00	551,32

In Turkey the Black Sea water the surveys period in 2012 is included 7 months (from January to April and from September). Abundance indices were estimated by 'swept area method' for the period of sprat fishing seasons (January-May) from commercial vessels (Sparre and Venema, 1992). The trawl survey samplings conducted is generally below of 40 m (minimum 24.7 m, maximum 113.0 m) depths along in the SSA and WBS littorals zones. In 2012 the mean catches per unit effort (CPUE) and abundance index are estimated respectively as 31.03 kg/km^2 and 1111×10-3kg/km^2 (Table 6.3.9-6.3.10). The stock is localized under the thermocline layer which is started about 40 m.

Table 6.3.9. Descriptive data regarding (kg/h) of whiting for 2011 and 2012 in the Samsun shelf area (SSA) and West Turkish Black Sea

Region	No of hauls	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CPUE/GENERAL	102	0.00	150.00	31.03	2.72	27.46
CPUE/SSA (EBS)	60	0.00	150.00	30.59	3.64	28.20
CPUE/ WBS	42	0.00	100.00	31.66	4.12	26.69

Table 6.3.10. The indicesof abundance ((N×10-3)and averagewhitingCPUE (kg/h)onto the Turkishresearchtrawl surveysin2009-2012

Age	2009	2010	2011	2012
0	1015.1	14.4	115.6	12.0
1	232.4	507.1	765.1	276.0
2	438.7	768.1	852.4	558.2
3	137.6	244.3	352.0	217.1
4	31.6	52.5	50.0	27.9
5	3.7	9.3	26.5	17.5
6	0.0	0.0	0.0	1.9
7	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.4
TOTAL	1859.1	1595.5	2161.5	1111.3
kg/h	212.7	56.7	52.1	31.0

6.3.3.1.3*Trends in growth*

No data presented.

6.3.3.1.4*Trends in maturity*

No data presented.

6.3.4 *Assessment of historic parameters*

6.3.4.1 Method 1: XSA

6.3.4.1.1*Justification*

An FLR XSA formulation has been accomplished as being documented in the previous sections.

6.3.4.1.2*Input parameters*

Input parameters have changed from EWG 12-10 since with the new data landings are not the same as estimated catches due to information relative to discard described in previous sections. A first step taken before the XSA was to correct the catch at age numbersto the official landings (SOP corrections) since there where clear discrepancies in the last 3-4 years (Fig. 6.3.18).

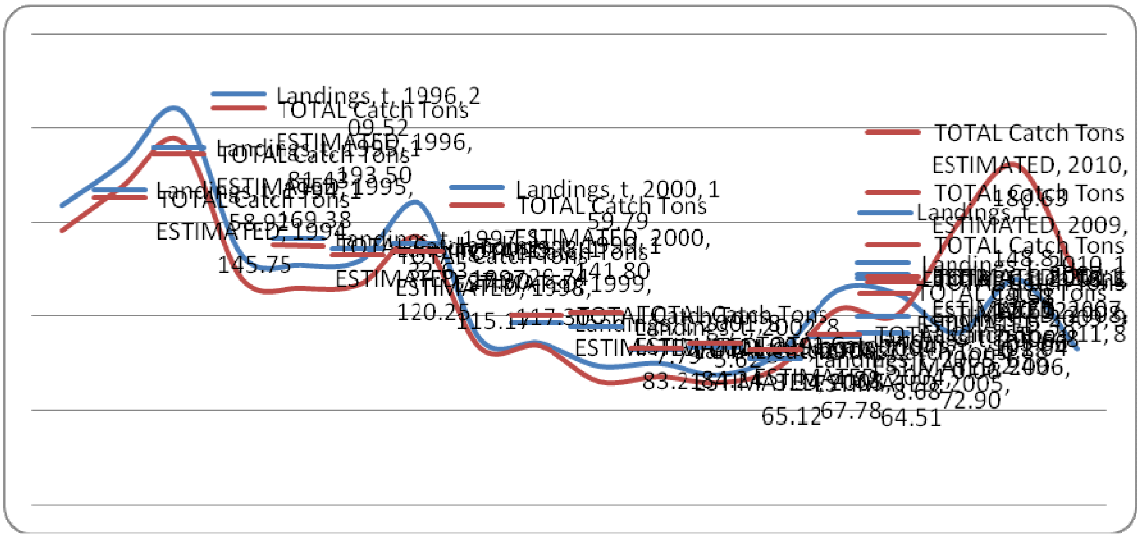


Fig. 6.3.18. Total landings in tons compared with Catch weights, a discrepancy is visible in particular in the past 3 years

Additionally the Catch Weight matrix in 2010 assessment used weights at age that had been derived across countries using a weighted average with weighting based on landings. This is now changed and an arithmetic mean is calculated across countries to derive mean weight at age.

Mean weight at age are available all years for age classes 1-5 but in several cases values are missing for age class 6 and thus a mean calculated in all years was used to replace missing values.

Maturity ogives are the same ones used in the 2012 assessment.

The survey tuning fleet from Romania is now complemented by a second survey from Turkey for the period 2009-2012 (Fig. 6.3.19).

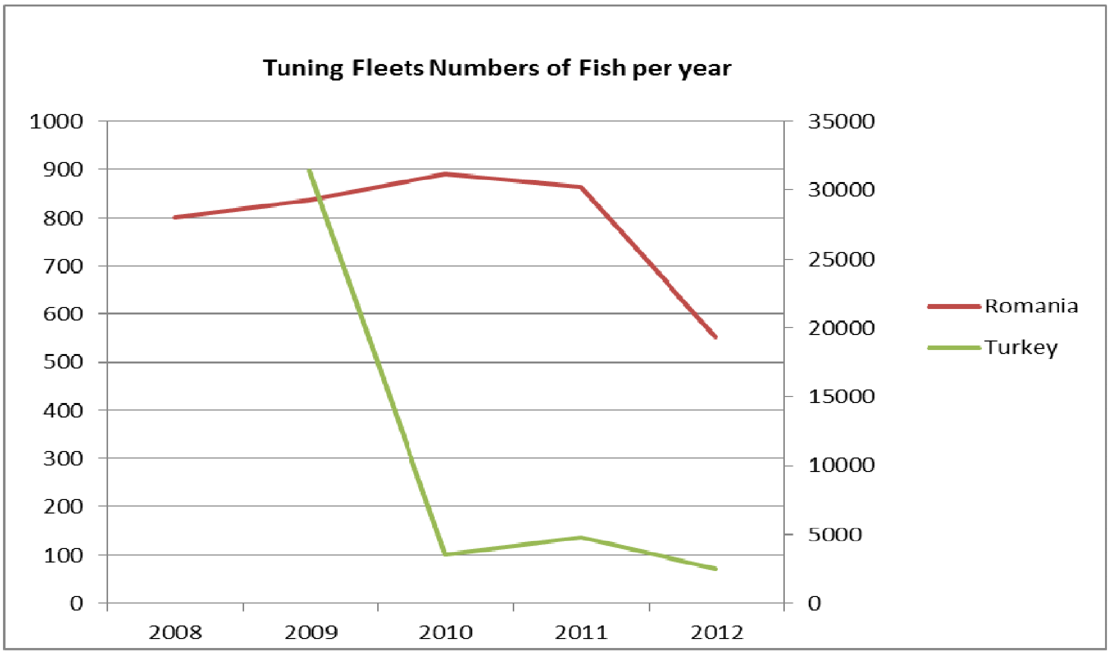


Fig. 6.3.19. CPUE tuning indexes from Romania and Turkey

Due to the newly documented varying discarding rates applying mostly to fish of age class 0 and 1, it was deemed reasonable to exclude these first two year classes from the XSA in order to reduce the bias introduced by the poorly documented discard rate. The assessment was thus run using ages 2 to 6+ for the both the catch matrix and the tuning indexes. This implies that comparison of the assessment to previous year is not fully appropriate. Indeed the SSB is on average reduced by approximately 10.000 tons and that the estimated recruitment will be not meaningful since it will represent age 2 and not age 0 or 1.

The entire input data to run the XSA is documented below:

```
An object of class "FLStock"
Slot "catch":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1994    1995    1996    1997    1998    1999    2000    2001    2002    2003    2004
  all  7420.7  6170.3  9322.1  6416.4  7543.3  7020.5  7572.5  3710.1  7595.3  5506.0  4942.3
     year
age   2005    2006    2007    2008    2009    2010    2011    2012
  all  2159.0  4505.6  6711.5  6839.1 10811.3 16980.9 10023.3  5868.8

units:  NA NA

Slot "catch.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994      1995      1996      1997      1998      1999      2000      2001      2002
  2 107202.98  47180.26 286057.69 222631.81 197953.34 183594.18 179416.21  93222.54  72623.95
  3 103846.70  81121.67  56801.10  48131.56  45023.22  40961.56  39082.10  27994.96  38878.11
  4  19147.77  16147.71  15904.31   1127.52  22920.91  21117.19  20465.23   6087.16  35817.47
  5    301.69   9095.50   1627.08      7.18   2567.44   3085.62   3886.40   2666.76  17162.60
  6      3.00   1704.75    852.18      3.00     60.29     60.99   3083.73   1144.45   5505.14
   year
age 2003      2004      2005      2006      2007      2008      2009      2010      2011
  2  74840.27 130642.68  15319.49 140259.30 171029.55 171954.42 315045.84 501698.56 297492.23
  3  28776.53  40633.52  36069.20  16030.10  33570.76  33404.47  98624.92 159792.38 122361.16
  4  23065.17   9376.14   5722.43   9570.18  13377.57  24181.05  22627.29  34366.38  17403.60
  5  15820.72   1084.49   1430.65   5540.56  10012.26   7254.26   2662.02   6259.57   9230.64
  6   2016.74      2.08    244.78    275.90   2703.79    709.21      3.00      3.00      3.00
   year
age 2012
  2 252673.18
  3  98008.37
  4  12669.59
  5   7933.75
  6   1140.65

units:  NA

Slot "catch.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994     1995     1996     1997     1998     1999     2000     2001     2002     2003
  2 0.020382 0.020382 0.020382 0.020382 0.020382 0.020382 0.021875 0.020582 0.023215 0.020971
  3 0.037392 0.037392 0.037392 0.037392 0.037392 0.037392 0.039440 0.037032 0.038541 0.038171
  4 0.069215 0.069215 0.069215 0.069215 0.069215 0.069215 0.068103 0.065100 0.061075 0.056156
  5 0.089646 0.089646 0.089646 0.089646 0.089646 0.089646 0.086428 0.081952 0.083937 0.081952
  6 0.123577 0.142178 0.142156 0.123577 0.141582 0.141589 0.122144 0.122146 0.142193 0.122145
   year
age 2004     2005     2006     2007     2008     2009     2010     2011     2012
  2 0.021096 0.019833 0.020400 0.020343 0.020430 0.019057 0.018603 0.016469 0.010947
  3 0.038728 0.038330 0.036835 0.038218 0.035574 0.033669 0.032816 0.030215 0.021212
  4 0.055832 0.057436 0.059149 0.058069 0.060426 0.056435 0.055310 0.046141 0.033861
  5 0.081952 0.080134 0.081952 0.082390 0.081707 0.078748 0.080323 0.067534 0.064329
  6 0.121980 0.119765 0.122154 0.128530 0.118179 0.109729 0.123577 0.123577 0.074105

units:  NA

Slot "discards":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
all 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

units:  NA NA

Slot "discards.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
```

```
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  6 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

units:  NA

Slot "discards.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  6 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

units:  NA

Slot "landings":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1994     1995     1996     1997     1998     1999     2000     2001     2002     2003     2004
  all  7420.7  6170.3  9322.1  6416.4  7543.3  7020.5  7572.5  3710.1  7595.3  5506.0  4942.3
     year
age   2005     2006     2007     2008     2009     2010     2011     2012
  all  2159.0  4505.6  6711.5  6839.1 10811.3 16980.9 10023.3  5868.8

units:  NA * NA

Slot "landings.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994      1995      1996      1997      1998      1999      2000      2001      2002
  2 107202.98  47180.26 286057.69 222631.81 197953.34 183594.18 179416.21  93222.54  72623.95
  3 103846.70  81121.67  56801.10  48131.56  45023.22  40961.56  39082.10  27994.96  38878.11
  4  19147.77  16147.71  15904.31   1127.52  22920.91  21117.19  20465.23   6087.16  35817.47
  5    301.69   9095.50   1627.08      7.18   2567.44   3085.62   3886.40   2666.76  17162.60
  6      3.00   1704.75    852.18      3.00     60.29     60.99   3083.73   1144.45   5505.14
   year
age 2003      2004      2005      2006      2007      2008      2009      2010      2011
  2  74840.27 130642.68  15319.49 140259.30 171029.55 171954.42 315045.84 501698.56 297492.23
  3  28776.53  40633.52  36069.20  16030.10  33570.76  33404.47  98624.92 159792.38 122361.16
  4  23065.17   9376.14   5722.43   9570.18  13377.57  24181.05  22627.29  34366.38  17403.60
  5  15820.72   1084.49   1430.65   5540.56  10012.26   7254.26   2662.02   6259.57   9230.64
  6   2016.74      2.08    244.78    275.90   2703.79    709.21      3.00      3.00      3.00
   year
age 2012
  2 252673.18
  3  98008.37
  4  12669.59
  5   7933.75
  6   1140.65

units:  NA

Slot "landings.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994     1995     1996     1997     1998     1999     2000     2001     2002     2003
  2 0.020382 0.020382 0.020382 0.020382 0.020382 0.020382 0.021875 0.020582 0.023215 0.020971
  3 0.037392 0.037392 0.037392 0.037392 0.037392 0.037392 0.039440 0.037032 0.038541 0.038171
  4 0.069215 0.069215 0.069215 0.069215 0.069215 0.069215 0.068103 0.065100 0.061075 0.056156
  5 0.089646 0.089646 0.089646 0.089646 0.089646 0.089646 0.086428 0.081952 0.083937 0.081952
  6 0.123577 0.142178 0.142156 0.123577 0.141582 0.141589 0.122144 0.122146 0.142193 0.122145
   year
age 2004     2005     2006     2007     2008     2009     2010     2011     2012
  2 0.021096 0.019833 0.020400 0.020343 0.020430 0.019057 0.018603 0.016469 0.010947
  3 0.038728 0.038330 0.036835 0.038218 0.035574 0.033669 0.032816 0.030215 0.021212
  4 0.055832 0.057436 0.059149 0.058069 0.060426 0.056435 0.055310 0.046141 0.033861
  5 0.081952 0.080134 0.081952 0.082390 0.081707 0.078748 0.080323 0.067534 0.064329
  6 0.121980 0.119765 0.122154 0.128530 0.118179 0.109729 0.123577 0.123577 0.074105

units:  NA

Slot "stock":
```

```
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  all 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

units:  NA * NA

Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year
age 1994       1995       1996       1997       1998       1999       2000       2001
  2 4.3111e+05 2.5823e+05 6.9143e+05 6.3161e+05 6.5139e+05 7.0072e+05 6.8530e+05 3.6296e+05
  3 1.8818e+05 1.4948e+05 1.0190e+05 1.5687e+05 1.7138e+05 1.9973e+05 2.3617e+05 2.3107e+05
  4 5.2769e+04 2.5702e+04 2.1422e+04 1.3500e+04 4.9754e+04 5.9931e+04 7.8331e+04 9.9514e+04
  5 6.1546e+02 1.4995e+04 2.2247e+03 3.3537e+01 6.6440e+03 1.0515e+04 1.7499e+04 2.8184e+04
  6 5.7437e+00 2.5716e+03 9.9515e+02 1.3598e+01 1.4867e+02 2.0016e+02 1.3464e+04 1.1850e+04
   year
age 2002       2003       2004       2005       2006       2007       2008       2009
  2 2.8433e+05 4.8901e+05 5.4640e+05 2.3249e+05 4.3895e+05 5.0779e+05 7.7443e+05 1.0358e+06
  3 1.2369e+05 9.7191e+04 2.0350e+05 1.9325e+05 1.1147e+05 1.2960e+05 1.4356e+05 2.8349e+05
  4 1.0492e+05 3.8550e+04 3.1597e+04 8.0622e+04 7.8413e+04 4.8750e+04 4.5675e+04 5.3381e+04
  5 5.0631e+04 3.1490e+04 4.1967e+03 1.0534e+04 4.0430e+04 3.6341e+04 1.7063e+04 7.3152e+03
  6 1.5564e+04 3.7593e+03 7.7788e+00 1.7604e+03 1.9662e+03 9.4684e+03 1.5814e+03 7.8776e+00
   year
age 2010       2011       2012
  2 1.1096e+06 8.4818e+05 6.6752e+05
  3 3.1741e+05 2.2079e+05 2.3121e+05
  4 8.1334e+04 5.4678e+04 2.9773e+04
  5 1.2744e+04 1.9499e+04 1.7352e+04
  6 5.7310e+00 5.9641e+00 2.3539e+03

units:  NA

Slot "stock.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994     1995     1996     1997     1998     1999     2000     2001     2002     2003
  2 0.020382 0.020382 0.020382 0.020382 0.020382 0.020382 0.021875 0.020582 0.023215 0.020971
  3 0.037392 0.037392 0.037392 0.037392 0.037392 0.037392 0.039440 0.037032 0.038541 0.038171
  4 0.069215 0.069215 0.069215 0.069215 0.069215 0.069215 0.068103 0.065100 0.061075 0.056156
  5 0.089646 0.089646 0.089646 0.089646 0.089646 0.089646 0.086428 0.081952 0.083937 0.081952
  6 0.123577 0.142178 0.142156 0.123577 0.141582 0.141589 0.122144 0.122146 0.142193 0.122145
   year
age 2004     2005     2006     2007     2008     2009     2010     2011     2012
  2 0.021096 0.019833 0.020400 0.020343 0.020430 0.019057 0.018603 0.016469 0.010947
  3 0.038728 0.038330 0.036835 0.038218 0.035574 0.033669 0.032816 0.030215 0.021212
  4 0.055832 0.057436 0.059149 0.058069 0.060426 0.056435 0.055310 0.046141 0.033861
  5 0.081952 0.080134 0.081952 0.082390 0.081707 0.078748 0.080323 0.067534 0.064329
  6 0.121980 0.119765 0.122154 0.128530 0.118179 0.109729 0.123577 0.123577 0.074105

units:  NA

Slot "m":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  2 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64
  3 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61
  4 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59
  5 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58
  6 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58

units:  NA

Slot "mat":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  2 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  0.9
  3 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  4 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  5 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  6 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0

units:  NA
```

```
Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994     1995     1996     1997     1998     1999     2000     2001     2002     2003
  2 0.419226 0.289828 0.843373 0.664397 0.542140 0.447564 0.447137 0.436494 0.433470 0.236689
  3 1.380857 1.332727 1.411329 0.538295 0.440683 0.326035 0.254246 0.179559 0.555832 0.513619
  4 0.668190 1.856933 5.869526 0.118982 0.964316 0.641056 0.432191 0.085729 0.613477 1.627658
  5 1.064511 1.663987 3.790630 0.337039 0.726565 0.497882 0.352134 0.135193 0.603325 1.112983
  6 1.064511 1.663987 3.790630 0.337039 0.726565 0.497882 0.352134 0.135193 0.603325 1.112983
   year
age 2004     2005     2006     2007     2008     2009     2010     2011     2012
  2 0.399386 0.095126 0.579893 0.623309 0.364963 0.542754 0.974555 0.659746 0.736635
  3 0.315912 0.291976 0.217031 0.432939 0.379310 0.638601 1.148725 1.393614 0.855794
  4 0.508434 0.100188 0.179039 0.459767 1.241587 0.842419 0.838211 0.557749 0.847569
  5 0.423655 0.200283 0.202291 0.459179 0.839703 0.666168 1.068407 1.001464 0.944275
  6 0.423655 0.200283 0.202291 0.459179 0.839703 0.666168 1.068407 1.001464 0.944275

units:  f

Slot "harvest.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  6 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

units:  NA

Slot "m.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  6 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

units:  NA

Slot "name":
[1] "BLACK SEA WHITING,2012,COMBSEX,PLUSGROUP,INDEX FILE"

Slot "desc":
[1] "Imported from a VPA file. ( BSW_94_2012IND.DAT ).  Thu Oct 17 15:07:19 2013 + FLAssess: "

Slot "range":
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar
        2         6         6      1994      2012         2         4
```

The control of XSA are reported below in R code:

FLXSA.control.bsw <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5,rage=2, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)

###Final settings

FLXSA.control.bsw1 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.0, rage=2, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)

FLXSA.control.bsw2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.0, rage=2, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)

6.3.4.1.3*Diagnostics and results*

After several tries the EWG choose a very light shrinkage in order to downweigth the trends in catchability residuals for the recruiting year class caused by very high tuning indices in the survey. The estimated stock spawning biomass temporal pattern is similar to the assessments results from EWG 12-09 although shifted down by 10.000 tons and with a continuous decline of SSB in the last 3 years. The estimated SSB in 2012, irrespective of XSA shrinkage level, reaches the lowest point of the time series available (Fig. 6.3.20).

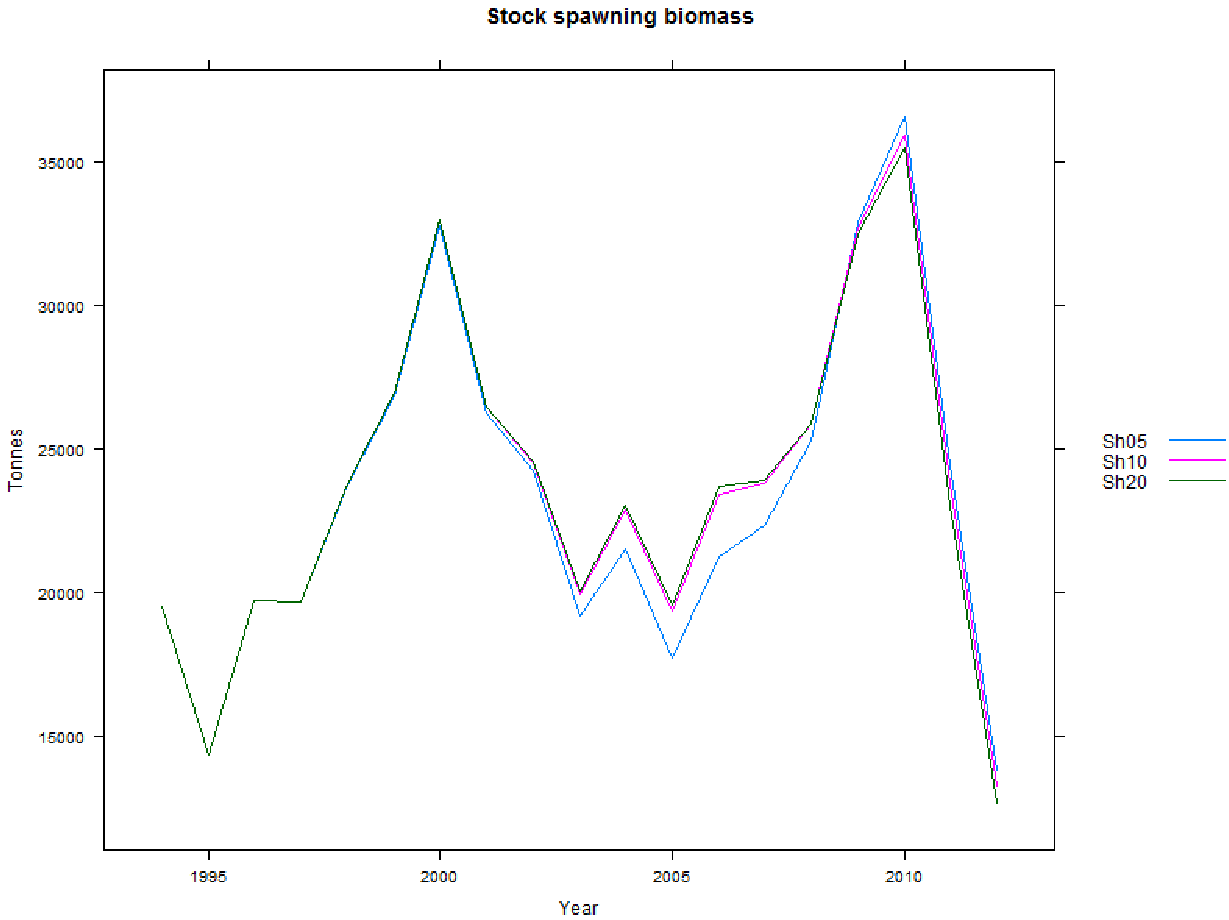


Fig. 6.3.20. Sensitivity analysis on Spawning Stock Biomass for different levels of shrinkage

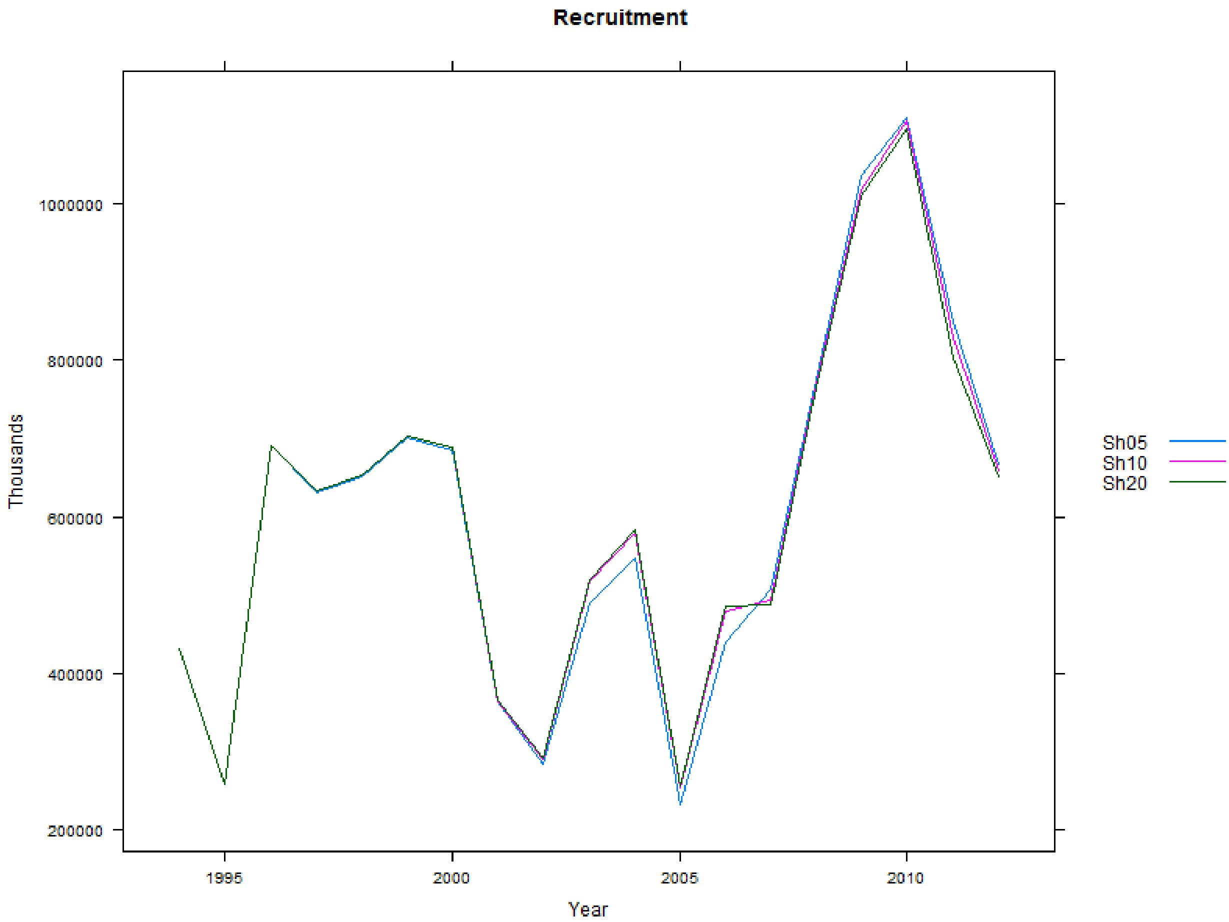


Fig. 6.3.21. Sensitivity analysis on Recruitment for different levels of shrinkage. In this assessment Recruitment is estimated on age 2, so it is not representative of younger age classes.

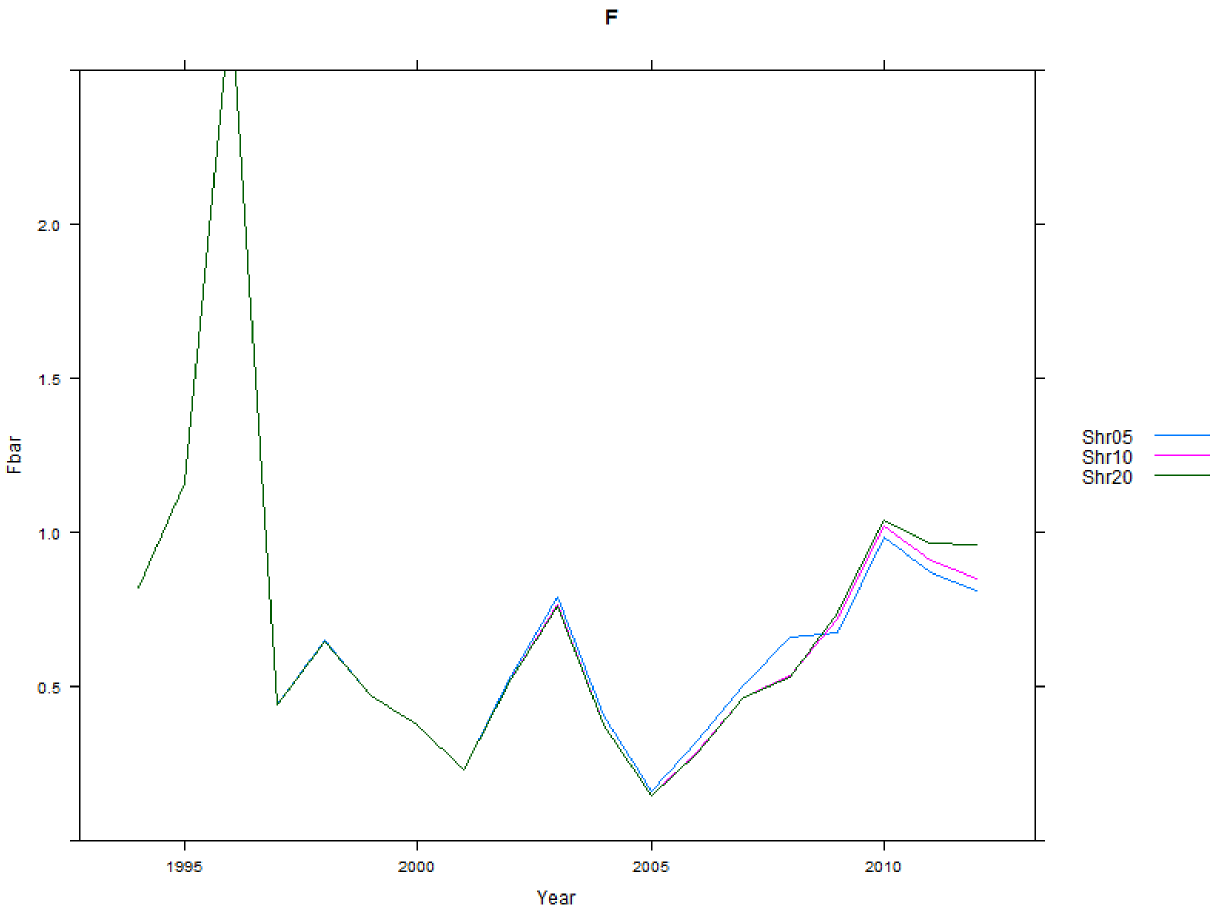


Fig. 6.3.22. Sensitivity analysis on Fbar(2-4) for different levels of shrinkage

The residuals of log transformed catchability are plotted for each tuning index and shrinkage level in Fig. 6.3.23 to 6.3.25, no model seems to fit better than the others.

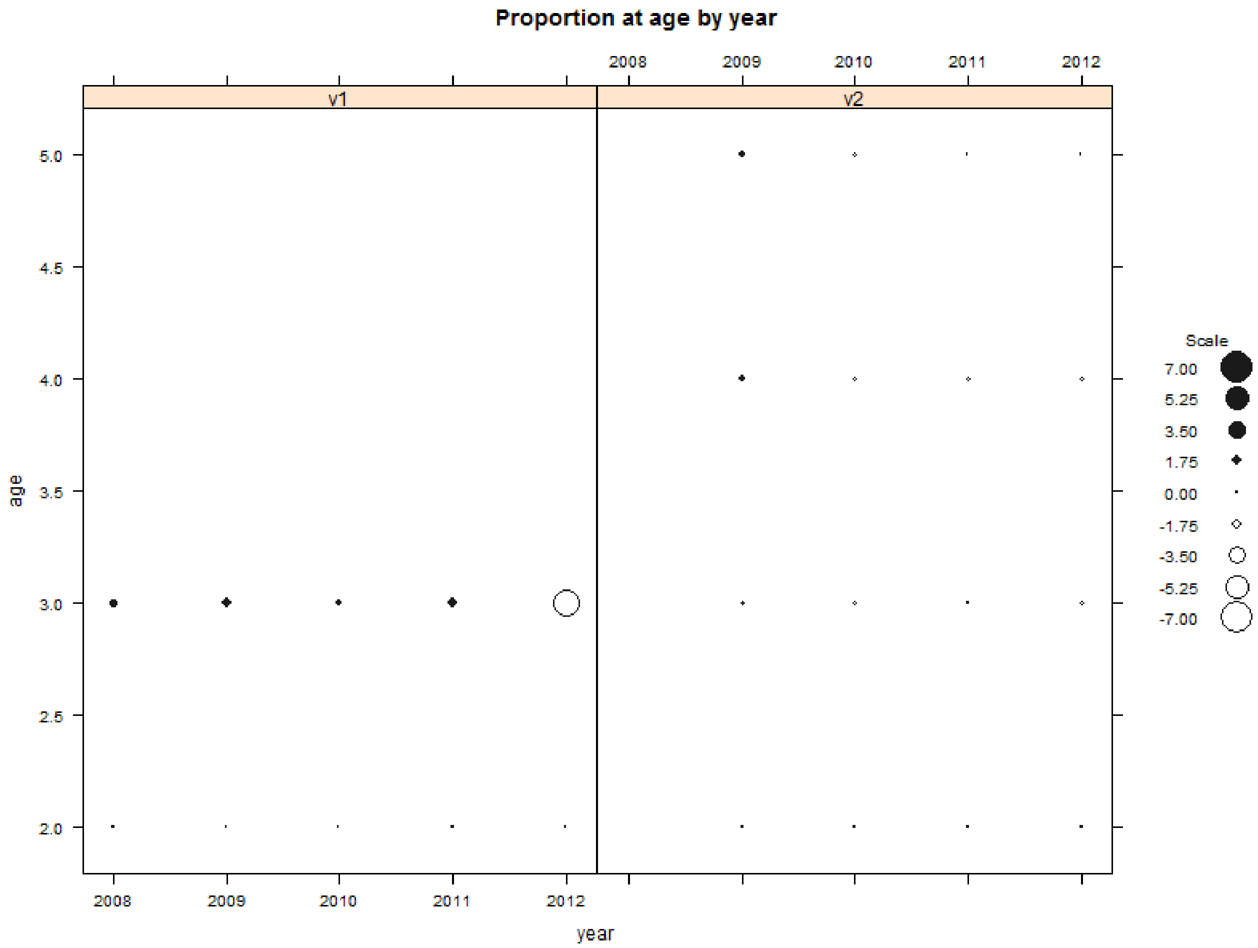


Fig. 6.3.23. Residuals of log transformed catchability applying a very low shrinkage of 0.5. V1=Romanian tuning index, V2=Turkish tuning index.

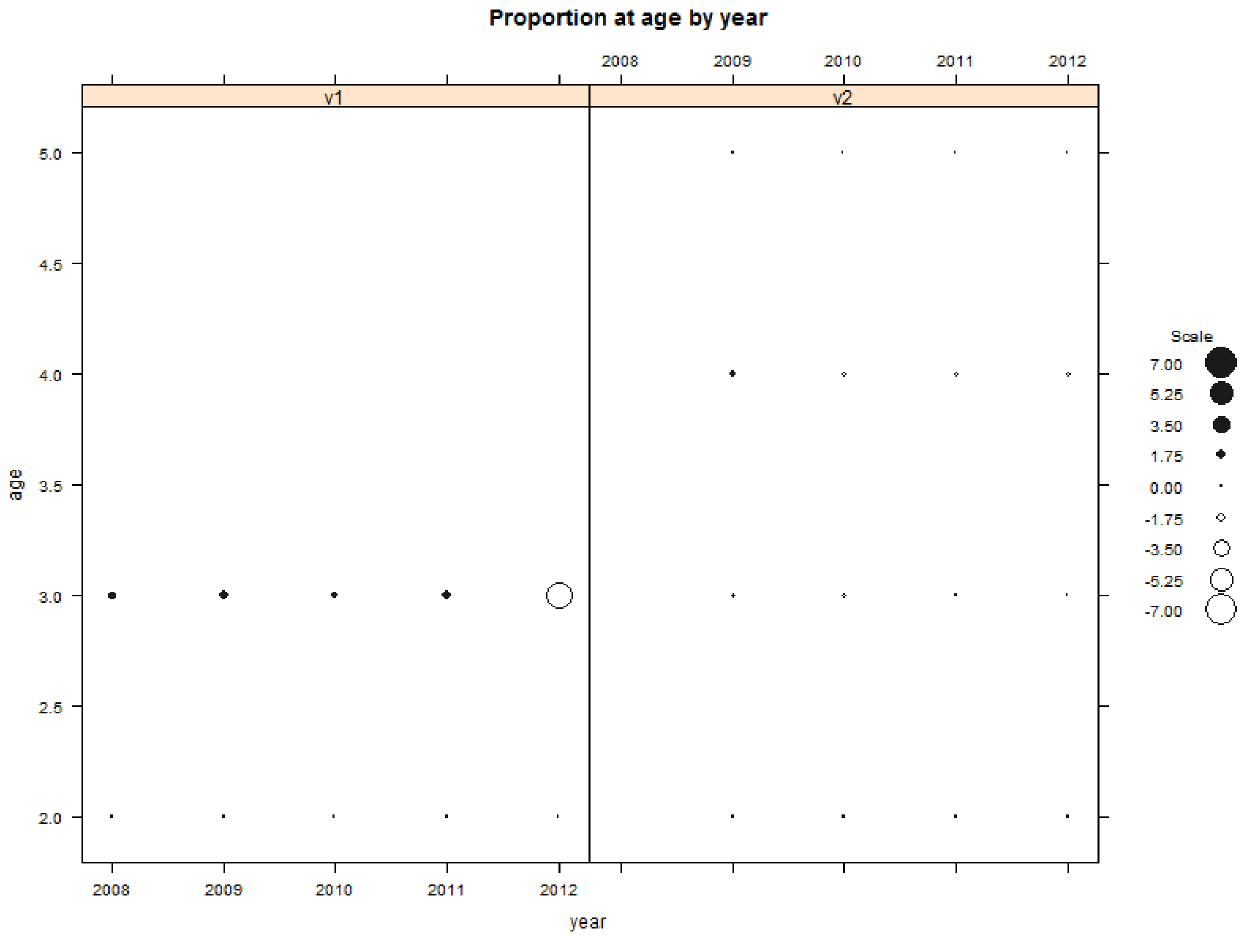


Fig. 6.3.24. Residuals of log transformed catchability applying a very low shrinkage of 1.0. V1=Romanian tuning index, V2=Turkish tuning index.

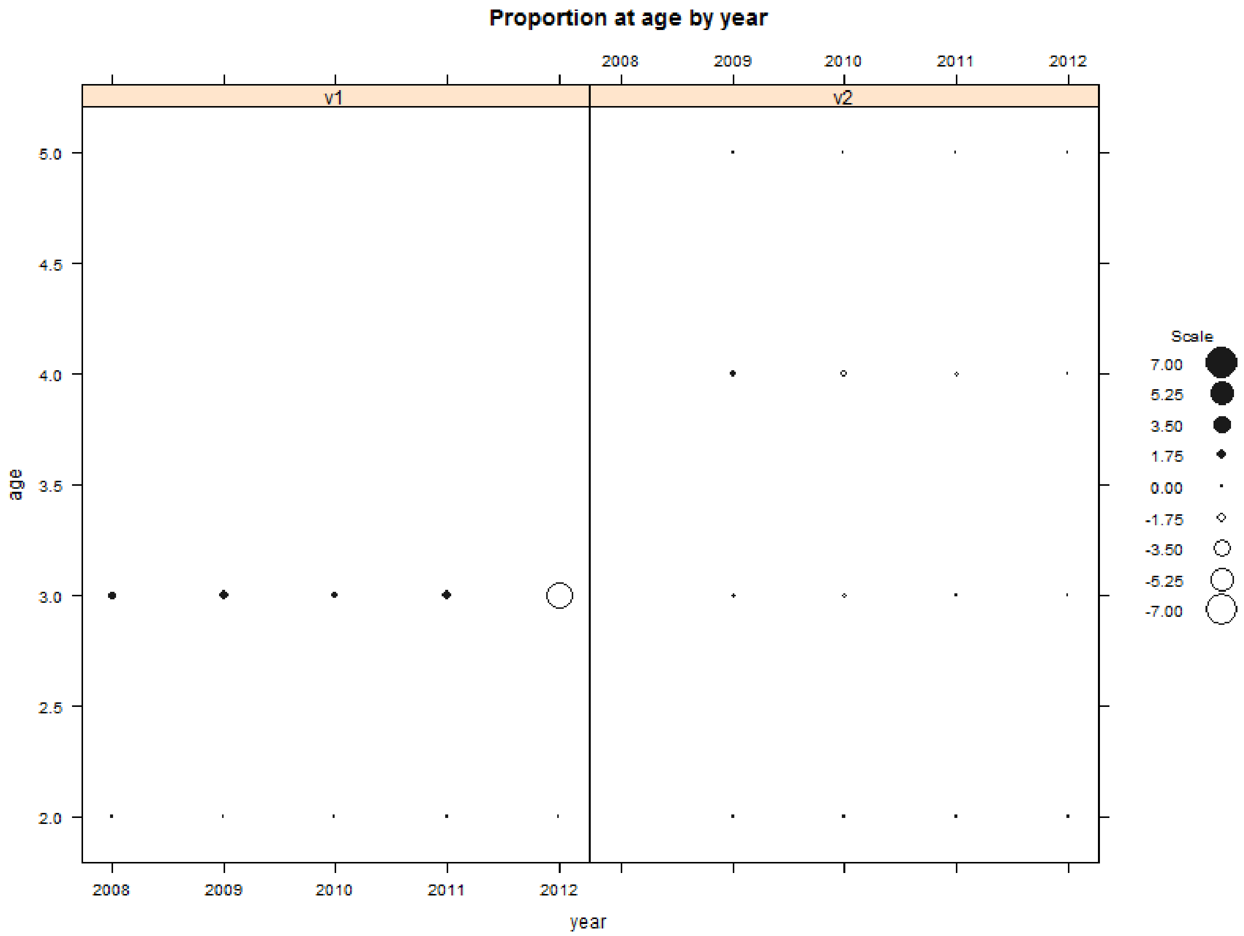


Fig. 6.3.25. Residuals of log transformed catchability applying a very low shrinkage of 2.0. V1=Romanian tuning index, V2=Turkish tuning index.

```
diagnostics(bsw.xsa2)
FLR XSA Diagnostics 2013-10-17 15:58:35

CPUE data from indices

Catch data for 19 years 1994 to 2012. Ages 2 to 6.

                              fleet first age last age first year last year alpha beta
1                     RO Trawl fleet         2         3       2008      2012  <NA><NA>
2 TR Trawl fleet (6 is a plusgroup)         2         5       2009      2012  <NA><NA>


 Time series weights :

    Tapered time weighting applied
   Power =   3 over   20 years

 Catchability analysis :

     Catchability independent of size for ages >   2

     Catchability independent of age for ages >   3

 Terminal population estimation :

     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  2 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   2
```

```
    Minimum standard error for population
    estimates derived from each fleet =  0.3

    prior weighting not applied

Regression weights
     year
age    2003 2004  2005  2006  2007  2008 2009  2010 2011 2012
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1


 Fishing mortalities
   year
age  2003  2004  2005  2006  2007  2008  2009  2010  2011  2012
  2 0.221 0.369 0.086 0.508 0.659 0.370 0.561 0.996 0.714 0.763
  3 0.489 0.289 0.261 0.193 0.351 0.416 0.654 1.247 1.506 1.027
  4 1.573 0.469 0.090 0.156 0.391 0.801 1.012 0.882 0.677 1.085
  5 1.071 0.389 0.179 0.178 0.381 0.628 0.278 2.037 1.149 1.570
  6 1.071 0.389 0.179 0.178 0.381 0.628 0.278 2.037 1.149 1.570


 XSA population number (Thousand)
      age
year        2      3     4     5     6
  2003  520202 100924 39091 32163  3847
  2004  583541 219953 33625  4497     8
  2005  255938 212831 89560 11658  1950
  2006  485241 123830 89054 45385  2210
  2007  488120 154015 55467 42240 11046
  2008  765380 133189 58938 20787  1945
  2009 1010853 278715 47745 14667    16
  2010 1095421 304245 78741  9620     4
  2011  802515 213300 47525 18061     5
  2012  651754 207137 25701 13387  1768

 Estimated population abundance at 1st Jan  2013
      age
year       2      3     4    5    6
  2013 181719 160183 40299 4814 1559


 Fleet:  RO Trawl fleet

 Log catchability residuals.

   year
age  2008   2009   2010  2011   2012
  2 0.075 -0.001 -0.062 0.099 -0.110
  3 1.546  1.776  1.033 2.067 -6.363

 Regression statistics
 Ages with q dependent on year class strength
[1] "0.500056413844808" "10.7782371129537"


 Fleet:  TR Trawl fleet (6 is a plusgroup)

 Log catchability residuals.

   year
age  2009   2010   2011   2012
  2 0.000  0.000  0.000  0.000
  3 0.805 -0.596  0.178 -0.380
  4 1.177 -0.871 -0.468 -0.336
  5 0.044 -0.246 -0.025 -0.040

 Regression statistics
 Ages with q dependent on year class strength
[1] "-3.45987373113255e-313" "0.00367113357789413"


 Terminal year survivor and F summaries:

 ,Age 2 Year class =2010
```

```
source
                                  scaledWts survivors yrcls
RO Trawl fleet                        0.354    128640  2010
TR Trawl fleet (6 is a plusgroup)     0.034    117635  2010
fshk                                  0.017    186429  2010
nshk                                  0.596    184840  2010

 ,Age 3 Year class =2009

source
                                  scaledWts survivors yrcls
RO Trawl fleet                        0.023        69  2009
TR Trawl fleet (6 is a plusgroup)     0.728     27553  2009
fshk                                  0.249     52352  2009

 ,Age 4 Year class =2008

source
                                  scaledWts survivors yrcls
TR Trawl fleet (6 is a plusgroup)     0.568      3440  2008
fshk                                  0.432      7987  2008

 ,Age 5 Year class =2007

source
                                  scaledWts survivors yrcls
TR Trawl fleet (6 is a plusgroup)     0.902      1498  2007
fshk                                  0.098      2973  2007
```

Fig. 6.3.26. Residuals of log transformed catchability applying a very low shrinkage of 2.0.

Retrospective patterns have been explored according to the different shrinkage levels.

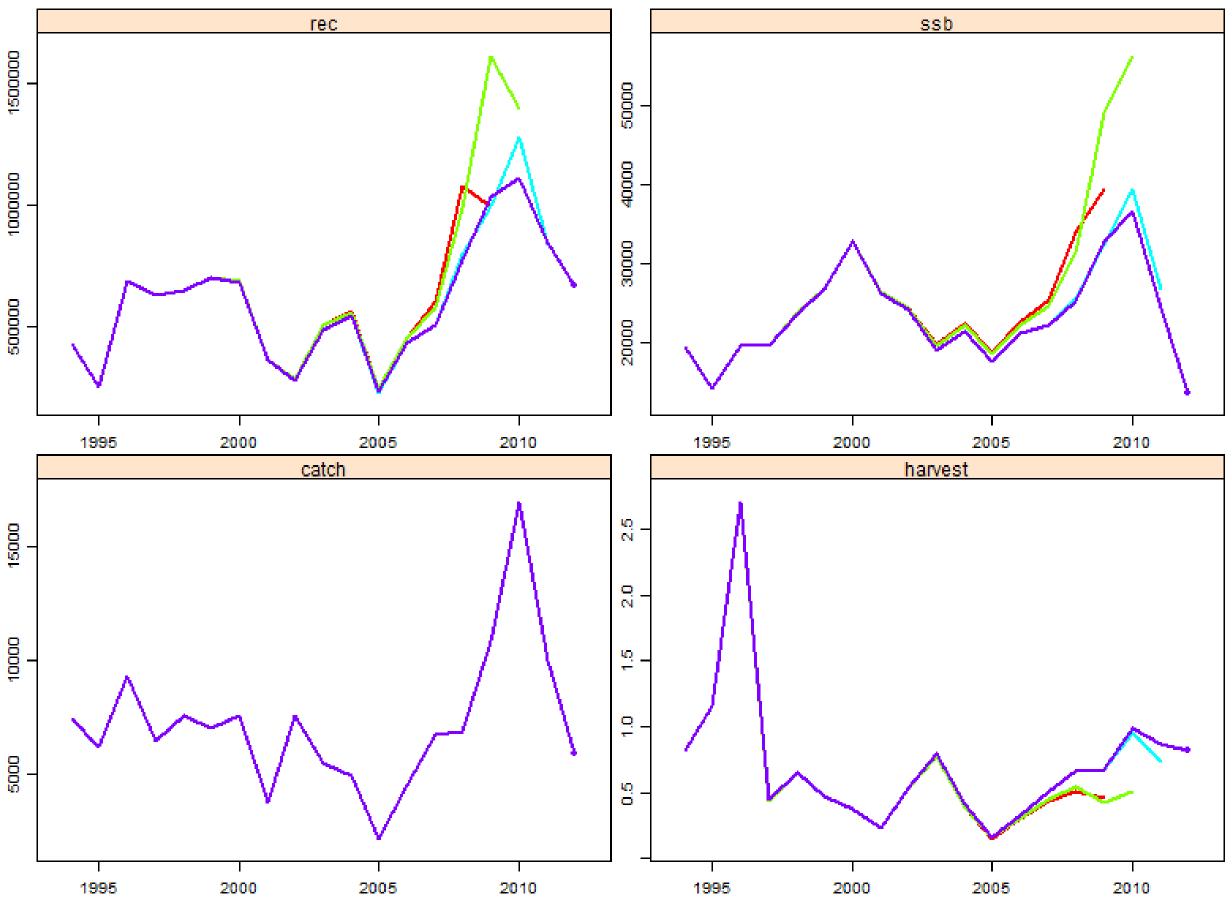


Fig. 6.3.27. XSA retrospective patterns for last 3 years with shrinkage (0.5). F is averaged over ages 2-4.

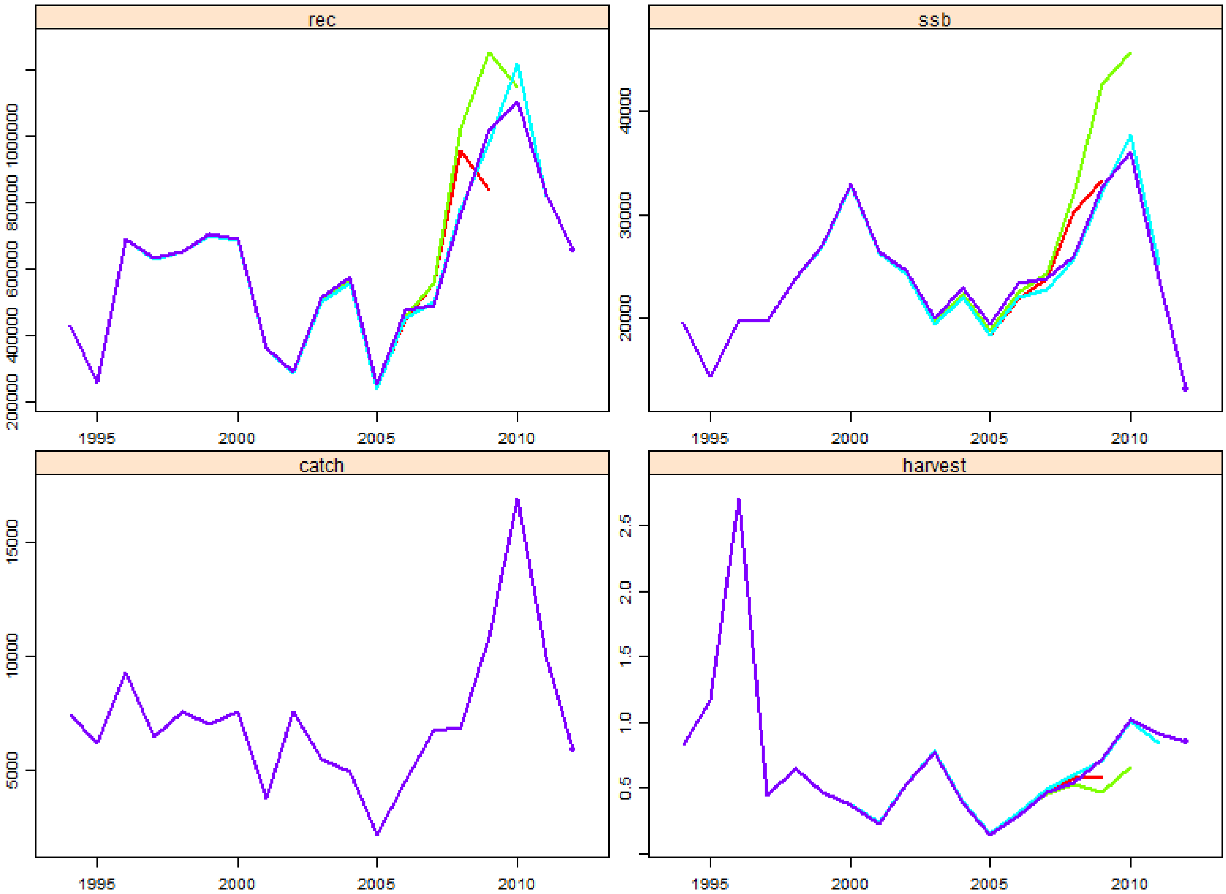


Fig. 6.3.28. XSA retrospective patterns for last 3 years with shrinkage (1). F is averaged over ages 2-4.

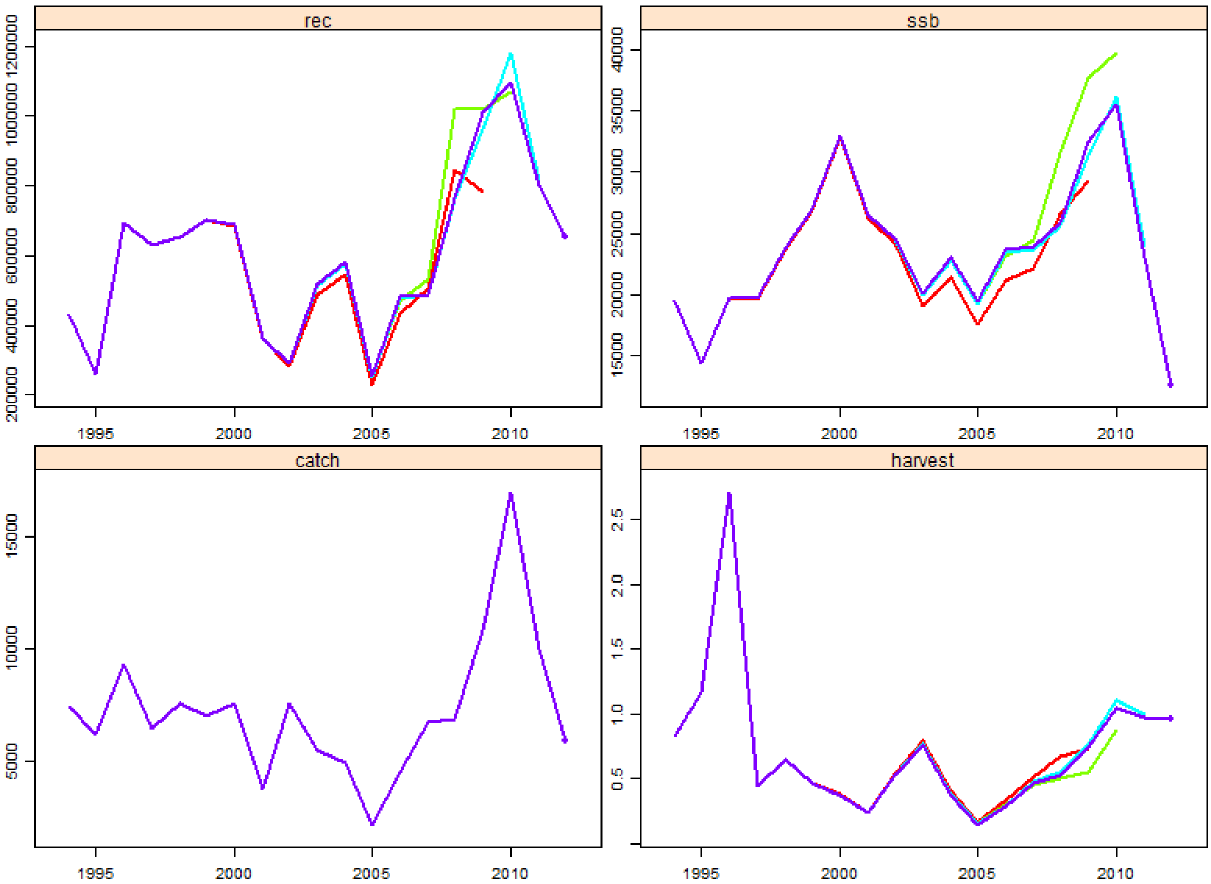


Fig. 6.3.29. XSA retrospective patterns for last 3 years with shrinkage (2). F is averaged over ages 2-4.

Overall the best model in terms of residual plots and retrospective patters is the model with shrinkage of 2 and this basis this XSA run is the retained one (Fig. 6.3.30). A zoom in on the mean F for ages 2-4 is plotted in Fig 6.3.31

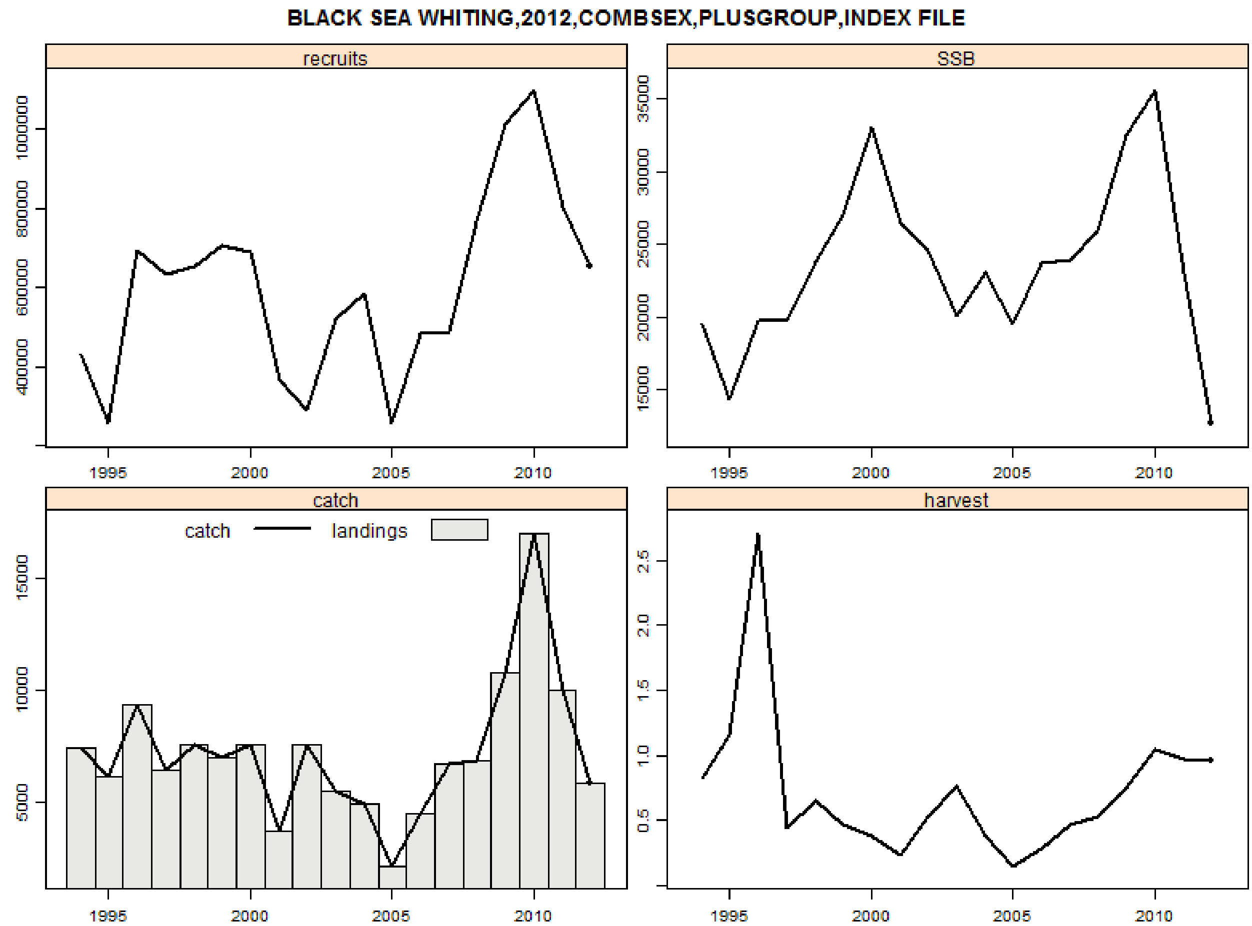


Fig. 6.3.31. Best final XSA assessment with shrinkage=2. F is averaged over ages 2-4.

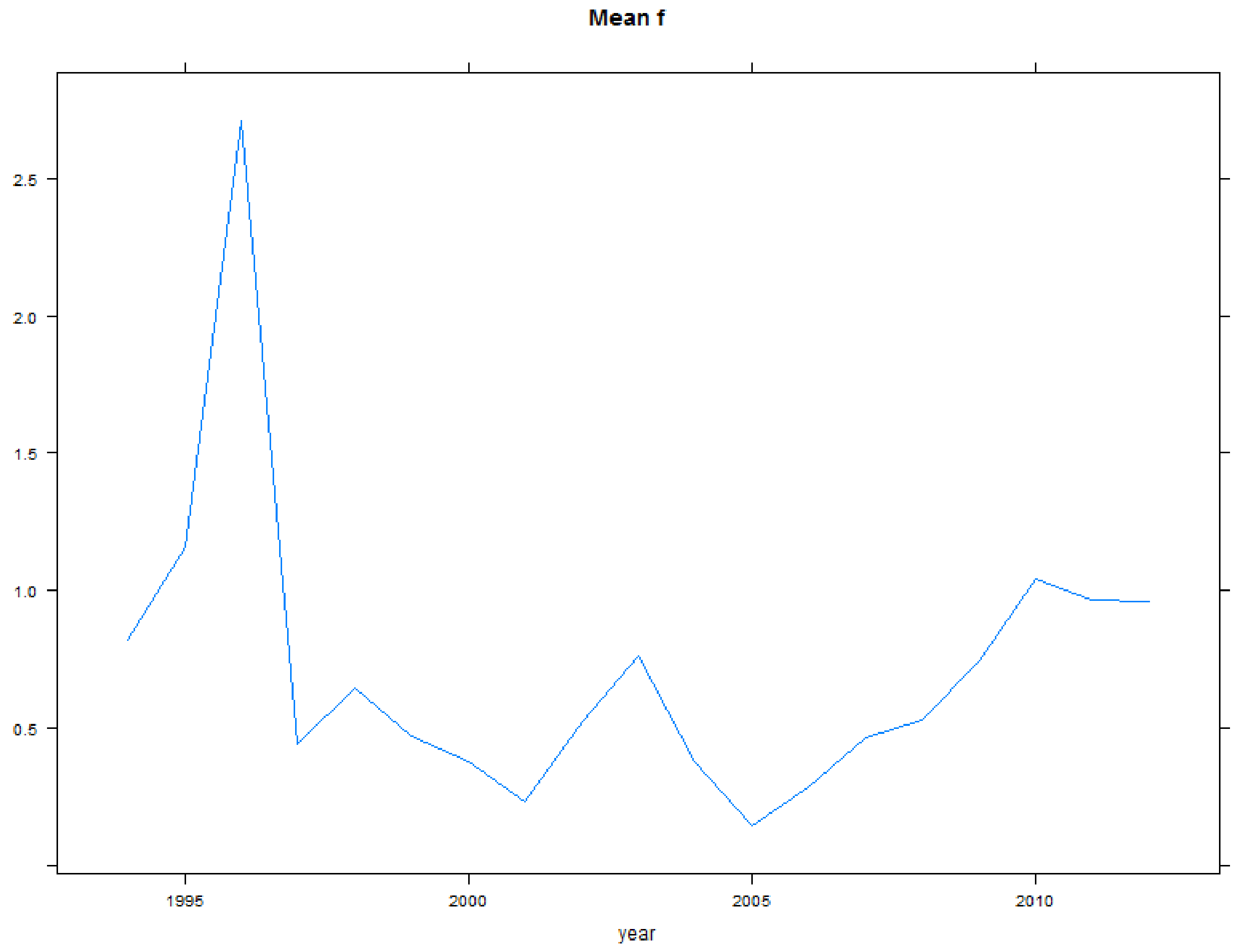


Fig 6.3.31. Mean F for ages 2-4 for Whiting in the Black Sea estimate in XSA run with shrinkage of 2.

6.3.5 *Short term prediction of stock biomass and catch*

A deterministic short term projection of stock size and catch was not performed due to the uncertainty in the assessment originated by the poor quality of the discard data.

6.3.6 *Long term predictions*

The EWG 13-12 did not undertake long term projections.

The EWG 12-09 proposed $F_{0.1}$=0.4 as approximation of the Fmsy reference point consistent with high long term yields, which is the same as in the meeting of the EWG 11-16.

6.3.7 *Scientific advice*

6.3.7.1 Short term considerations

State of the spawning stock size:

Since 1994 the SSB has varied without a trend. In the absence of a biomass biological reference points the EWG 13-12 is unable to fully evaluate the stock status in respect to it.

State of recruitment:

EWG 13-12 is unable to fully evaluate the state of recruitment due to the selection of only age 2-6+ for the assessment.

State of exploitation:

The EWG 12-16 proposed F_{msy} (1-4)≤0.4 as limit reference point consistent with high long term yields and low risk of fisheries collapse. As the estimated F(2-4)= 0.95843exceeds F_{msy}, the EWG 13-12 classifies the stock of whiting in the Black Sea as being potentially exploited unsustainably although given the uncertainty in discards the assessment is mainly indicative of trends. The EWG 12-16 notes the geographically uneven pattern in the catches of this stock. Given that this is not a highly migratory species we may conclude that the resident population is more exploited in the southern part (Turkish waters) than in the rest of the Black Sea - an effect that has been demonstrated by Prodanov et al. (1997) who performed separate VPA analyses of the western/northern and eastern/southern components of the whiting stock.

6.3.7.2 Medium term considerations

Due to the lack of discard information in the catch statistics, which might bias the assessment, no medium term analyses have been conducted.

6.4 Horse mackerel in the Black Sea

6.4.1 *Biological features*

6.4.1.1 Stock Identification

The Black sea horse mackerel is a subspecies of the Mediterranean horse mackerel *Trachurus mediterraneus.* Although in the past the Black sea horse mackerel has been attributed to various subpopulations, in a more recent study Prodanov *et al.*(1997) brought evidence that the horse mackerel rather exists as a single population in the Black sea, and thus all Black sea horse mackerel fished across the region should be treated as a unit stock.

The horse mackerel is a migratory species distributed in the whole Black Sea (Ivanov and Beverton, 1985, Fig. 6.4.1.1.1). In the spring it migrates to the north for reproduction and feeding. In summer the horse mackerel is distributed preferably in the shelf waters above the seasonal thermocline. In the autumn it migrates towards the withering grounds along the Anatolian and Caucasian coasts migration (Ivanov and Beverton, 1985). The horse mackerel population in the Black Sea mainly winters along the Crimean, Caucasian and Anatolian coasts and warm sections of the Marmara Sea. They winter at a depth ranging between 20 and 90 meters off Crimea and between 20 and 60 meters off the Caucasian coasts. The horse mackerel population continuously remains in the eastern Black Sea winters in an area north-east of Trabzon. The population migrating between Marmara and the eastern Black Sea spend the winter in the Bosphorus area and off the Marmara Sea at optimal depths ranging between 30 and 50 meters. Depending on water temperature, feeding migration starts in mid-April or towards the end of that month (Demir, 1958). Horse mackerel groups migrate from the Bosphorus to the Bulgarian and Romanian coasts in the north. They are also believed to migrate from Crimea to the north-west and from the Caucasian and north-eastern Anatolian coasts to the Crimean coasts. Autumn migration starts in September and reaches a peak in October and November (Ivanov and Beverton, 1985).

The family Carangidae is represented by two species in the Black Sea: *Trachurus trachurus* and *T. mediterraneus* (Drenski, 1948, 1951;Aleev, 1956; Georgiev and Kolarov, 1959, 1962; Stoyanov *et al.,* 1963; Svetovidov,1964; Valkanov *et al.,* 1978; Sivkov, 2004; Zhivkov *et al.,* 2005; Kapapetkova and Zhivkov, 2006; Raykov and Yankova, 2008; Yankova *et al.,* 2010a). The systematic position of the Black Sea horse mackerel was examined by Nümann (1956) and Aleev (1952, 1957). These authors stated that in the Black Sea the species is represented by four local subpopulations: a south western (Bosporic), a northern (Crimean), an eastern (Caucasian) and a southern (Anatolian). Each subpopulation has its own biological characteristics such as wintering grounds, fat content, spawning patterns, age composition, growth rate, feeding patterns.

According to some authors (Aleev, 1956; Georgiev and Kolarov,1959, 1962; Stoyanov *et al.,* 1963; Kapapetkova and Zhivkov, 2006) the Black Sea horse mackerel is represented into two size-forms: ”large” and “small”. The presence of the largeform has been reported for a first time in 1913 by S. A. Zernov (Aleev, 1956). However, after that time this form disappeared,but it is registered again in the territorialwaters of Georgia in 1947 and is being intensively fished for 10 years.Draughts of the large formfor the eastern part of theBlack Sea reached up to 8601,7 tin 1954 (Tikhonov*et al.,* 1955). Since 1958, onlysingle specimens are found in the nets (Dobrovolov, 2000).There are several hypotheses about thepresence of the large horse mackerel in the Black Sea: a) it is a new immigrant fromthe Mediterranean (Aleev, 1956); b) it isthe same small horse mackerel with accelerated growthunder extremely favorable conditions(Tikhonov*et al.,* 1955; Shaverdov, 1964); c) it is an ecological breed that hibernates inthe warmest areas (Aleev, 1957), or it is anecotype (Shaverdov, 1964); d) it belongs toanother species present in theMediterranean or even in the AtlanticOcean and in case of extremely high speciesnumbers some shoals enter the Black Seaenlarging their nutritive territory(Altukhovand Salmenkova, 1981); e) it is apolyploid form of the small horse mackerel originatingin the Black Sea (Georgievand Kolarov,1962); f) it is a "giant" horse mackerelas a new species*Trachurus gigas*, n.sp (Banarescu and Nalbant, 1979).

According to Shaverdov (1964), the "large" and "small" forms of the BlackSea horse mackerel belongs to one and the same subspecies asdescribed by Aleev (1957). After the study of Golovko (1964) about the electrophoretic spectraof serum proteins from these two forms, Shulman and Kulikova (1966) reconsidered their ownearlier assumption about the belonging ofboth forms to a taxonomically closebut different species. Tkacheva (1957) performscrosses between small and large horse mackerelunder field conditions on board a researchmotor boat, which showed the possibility toobtain hybrids.Until now, there does notexist any information confirming the polyploidityof the large form of horse mackerel. On the other hand, the existence of two different subspecies of *T. mediterraneus* in theBlack Sea:*T. m.* ssp. *ponticus* and *T. m.* ssp. *mediterraneus* is described by Altukhov and Apekin (1963) based on serological analysesandalso by Altukhov and Michalev (1964) by means of the characteristics of the cellular thermal (Prodanov *et al.,* 1997). According to (Dobrovolov & Dobrovolova 1983;Dobrovolov and Manolov 1983;Dobrovolov, 1988)no difference at species level can be found between *T. mediterraneus* ssp. *ponticus* and *T. mediterraneus* ssp. *mediterraneus* by electrophoretical method. Dobrovolov (1986) revealed that the occurrence of large form can be explained as a result of heterosis effect between the above-mentioned subspecies.

Turan(2004) analysed the population structure of *T. mediterraneus* inTurkish coastal waters using morphometric and meristic traitsand reported on population structuring in three areas: theBlack Sea, Marmara Sea and the north-east MediterraneanSea. The samples from the Black Sea were similar to each other for both morphometric and meristic charactrers.Biometric indices were insufficient to distinguish twohorse mackerel subpopulations in the Bulgarian and Turkish Black Sea waters (Yankova and Raykov, 2006a). The same authors concluded that all of the morphological differences are possible due to variability of the habitat and sample size of the study. Acording to Prodanov *et al.,* (1997) the Black Sea horse mackerel represent a single population, as the environmental conditions are almost one and the same in the whole area inhabited, and there exists no positive evidence for the occurrence of two distinct subpopulations differing substantially in their biological parameters.Thepresent mtDNA analysis also indicated that there were no subspecies of*T. mediterraneus*from the Turkish Black Sea waters (Bektas and Belduz, 2008).

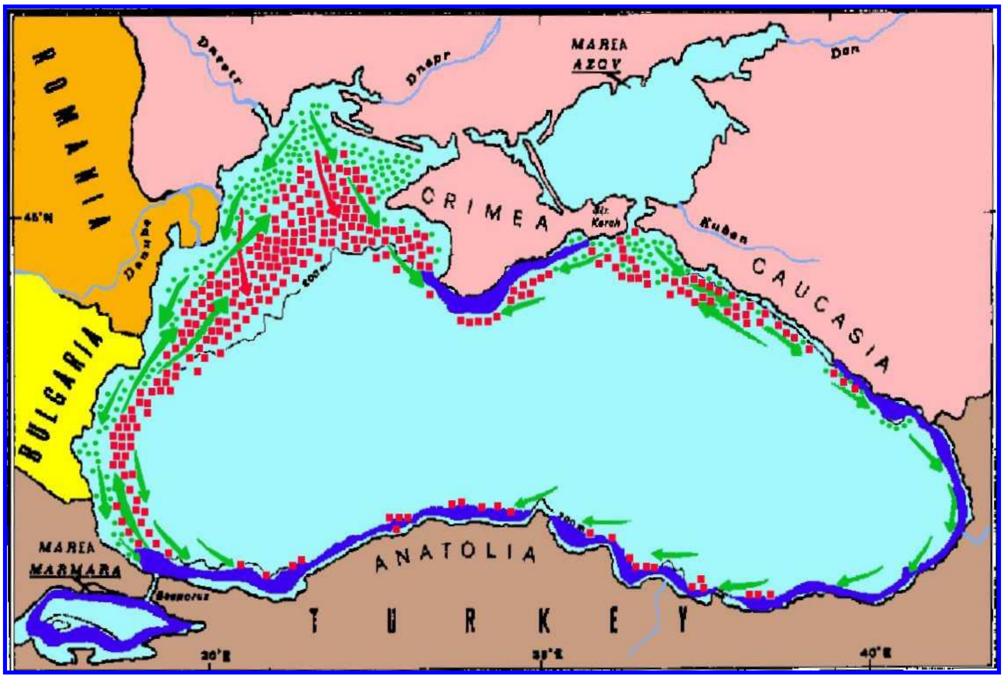


Fig.6.4.1.1.1 Distribution and migration routes of horse mackerel in the Black Sea.

6.4.1.2 Growth

Horse mackerel growth parameters from VBGF and length-weight relationship, provided by different countries are presented in Table 6.4.1.2.1.

The exponent *b* ranged between3.3029 for females and 3.3123 for males, exhibitingpositive allometric growth (Yankova *et al.,* 2010). There was not a significantdifference when the length-weight relationships of thesexes were compared using covariance ($P > 0.05$).The slope (*b* value) of the length-weightrelationship was similar for males (3.3123) andfemales (3.3029), indicating that weight increasedallometrically with length (Yankova *et al.,* 2010; Yankova, 2013a; Yankova, 2013b).

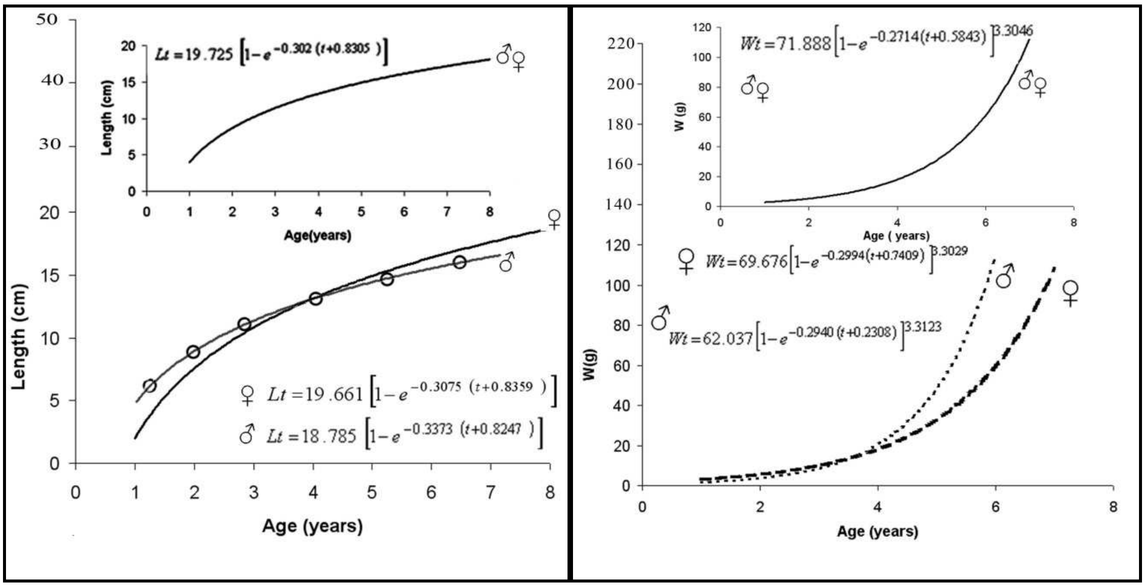


Figure6.4.1.2.1. Length-weight growth curves of horse mackerel males, femalesand both sexes combined from Bulgarian Black Sea waters(afterYankova *et al.,* 2010).

Comparison of the growth parameters ofhorse mackerel in Bulgarian Black Sea waters (Yankova *et al.,* 2010) showed that there were no differences (ANOVA, F= 1.40, P > 0.05). During thefirst 3 years of life females and males differ in length (Figs. 6.4.1.2.1).Males are characterized by higher growth rates thanfemales(Yankova *et al.,* 2010).

Table 6.4.1.2.1. VBGF parameters calculated in the Black Sea

COUNTRY	**YEAR_PERIOD**	**SPECIES**	**SEX**	**L_INF**	**K**	**t_0**	**a**	**b**
Bulgaria	2007-2008	HMM	C	19.75	0.3020	-0.830	0.0035	3.3046
Bulgaria	2007-2008	HMM	M	18.785	-0.3373	-0.825	0.0034	3.3123
Bulgaria	2007-2008	HMM	F	19.661	-0.3075	-0.836	0.0038	3.3029
Romania	2000	HMM	C	18.6	0.224	-1.430	0.0380	2.3552
Romania	2001	HMM	C	18.95	0.268	-0.630	0.0470	2.3501
Romania	2009	HMM	C	18.42	0.42	-0.410	0.0450	2.3469
Romania	2010	HMM	C	20.03	0.302	-0.467	0.0111	2.9065
Romania	2011	HMM	C	17.37	0.371	-0.445	0.0101	2.9101
Romania	2012	HMM	C	16.84	0.2686	-1.811	0.01075	2.883
Turkey	1991 – 1992	HMM	M	19.9	0.396	-1.020	0.0110	3.18
Turkey	1991 – 1992	HMM	F	20.6	0.356	-1.110	0.0080	2.993
Turkey *	2005	HMM	C	20.237	0.3181	-1.603	0.0081	2.9983
Turkey *	2006	HMM	C	22.394	0.241	-1.932	0.0064	3.0986
Turkey *	2007	HMM	C	22.232	0.2554	-1.828	0.0085	2.984
Turkey *	2008	HMM	C	22.244	0.2538	-1.80	0.0069	3.1018
Turkey *	2009	HMM	C	24.023	0.2082	-2.075	0.0062	3.1024
Turkey *	2010	HMM	C	25.002	0.187	-2.11	0.0052	3.1654
Turkey *	2011	HMM	C	24.44	0.235	-1.767	0.0056	3.1402
Turkey *	2012	HMM	C	21.36	0.287	-1.84	0.0059	2.8831
Ukraine	2008	HMM	C	18.5	0.343	-0.66	_	_

**data according "Purse seine fisheries monitoring project by Trabzon Central Fisheries Institute"*

6.4.1.3 Maturity

The horse mackerel matures at age of 1-2 years during the summer, which is also the main feeding and growth season. It spawns in the upper layers, mainly in the open part of the sea as well as near the coast (Arkhipov, 1993). Eggs and larvae are often found in areas with a low productivity and higher salinity (Arkhipov, 1993). Daskalov (1999) has found that horse mackerel recruitment is related to divergence and increased productivity of the sea. Peak spawning in the Bulgarian Black Sea Coast falls between June-August (Georgiev *et al.,* 1961; Georgiev and Kolarov, 1962; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963, Karapetkova and Zhivkov, 2006; Yankova and Raykov, 2009; Yankova, 2011). Spawning has been reported to occur 20 miles off the coast (Georgiev *et al.,* 1962). The pelagic eggs are 0.73-1.00 mm (Georgiev *et al.,* 1961; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963) and hatch after four days (Radu and Radu, 2008) at local temperatures 16-26 °C and salinity is 15.5-19‰(Georgiev *et al.,* 1961; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963). The eggs of horse mackerel are pelagic, spherical, with a drop of fat (Karapetkova and Zhivkov, 2006).

The horse mackerel reproduction start at age of 1 year during the summer in Southern Black Sea (peak July), reproduction temperature is between 18-25 °C , salinity salinity is 16-18 ‰(Genç*et al.,* 1999).

6.4.2 *Fisheries*

6.4.2.1 General description

The horse mackerel (*Trachurus mediterraneus*) fishery operates mainly on the wintering grounds in the southern Black Sea using purse seine and mid-water trawls. The horse mackerel of age 1-3 years generally prevails in the commercial catches, but strong year classes (for example, the 1969-year class) may enter into exploitation at age of 0.5 year and may prevail up to age 5-6 years. Over the last 40 years, highest horse mackerel catches were reported in the years preceding *M. leidyi* outbreak (1988-1990). (Prodanov *et al*., 1997; FAO, 2007). The maximum catch of 141 thousand tons was recorded in 1985, from which ~100 thousand tons were caught by Turkey (Prodanov *et al*., 1997). In the next four years catches remained at the level of 97-105 thousand tons. In the period 1971-1989, the stock increased, although years of high abundance alternated with years of low abundance due to year class's fluctuations, typical of this fish. VPA estimates showed that the stock was highest in 1984-1988 (Prodanov *et al*., 1997). Scientists (Chashchin, 1998) believed that the intensive fishing in Turkish waters in 1985-1989 has led to overfishing of horse mackerel population and reduction of the stock and catches in the next years. A drastic decline in stock abundance occurred after 1990 when the stock diminished by 56%. In 1991 the horse mackerel stock dropped to a minimum of 75 thousand tons and the catch dropped to 4.7 thousand tons that is a twenty fold reduction compared to the average annual catch in 1985-1989.

The horse mackerel recruitment has been highly variable with the stock biomass supported by sporadic strong year-classes (e.g. 1969, 1983, 1987) followed by weak-ones. Thus, the influence of a strong year-class can be traced through the subsequent few years of biomass increase. No evidence of reliable stock-recruitment relationship has been found (Daskalov, 1999). The relationship with selected environmental variables has been explored by (Daskalov 1999, 2003; Yankova *et al*., 2013). A strong negative correlation was with surface temperature (SST) has been found. It may appear surprising for a warm-water summer spawning species to correlate negatively with SST. Such relationships have been also found however in other studies (Simonov *et al*., 1992). The effect of the wind stress was significant and generally positive. These results indicate that horse mackerel recruitment has been more abundant in years with increased physical forcing and enrichment, probably related to the spawning distribution wide spread over areas of low productivity.

During 1985-1993, only in 1988 a relatively successful recruitment was recorded. Despite of its coincidence with the first year of *M. leidyi* outbreak, the juveniles from this cohort were sufficiently well supplied with food. As the first burst of *M. leidyi* occurred in the autumn of 1988, the summer zooplankton maximum production did not suffer much from the devastating effect of *M. leidyi*. The copepods *Oithona nana* and *Oithona similis*, constituting the main food of larval horse mackerel (Revina, 1964), were especially abundant. However, the favorable trophic conditions for larvae in summer 1988 failed to ensure the formation of numerically strong year-class because further in the year juveniles were faced with strong feeding competition with *M. leidyi*. Sharp decline in *Oithona* under the predation pressure of *M. leidyi* in the subsequent years (Vinogradov *et al*., 1993 ;) affected the survival of horse mackerel. Dietary studies of juvenile and adult horse mackerel (Revina, 1964) have shown that both the habitat diet of juvenile horse mackerel and *M. leidyi* overlap, therefore the strong feeding pressure by *M. leidyi* on zooplankton directly affected larval and juvenile horse mackerel. Food in relation to fish size shows that the most important for the diet of horse mackerel groups are *Mysidacea* and *Pisces.* The contribution of the rest of groups was relatively low(Yankova & Raykov, 2010). The same authors reveal that main prey of the Black Sea horse mackerel is fish and zooplankton. This group represents over 55% of the total IRI and was the main food for this species. Besides having the largest number of zooplankton, it had a high impact on populations of commercial fish such as sprat and anchovy.

Over the last 40 years, highest horse mackerel catches were reported in the years preceding *M. leidyi* outbreak (1988-1990). Quantitative stock assessments showed that the stock was highest in 1984-1988, although years of high abundance alternated with years of low abundance due to year classes' fluctuations, typical of this species. Scientists believed that the intensive fishing in Turkish waters in 1985-1989 has led to over fishing of horse mackerel population and reduction of the stock and catches in the next years. A drastic decline in the stock abundance occurred after 1990 when the stock diminished by 56%. In 1991 the horse mackerel stock dropped to a minimum of 75 thousand tons and the catch dropped to 4.7 thousand tons, hat is a twenty fold reduction compared to the average annual catch in 1985-1989. In contrast to anchovy and sprat, the horse mackerel stock still remains in a depressed state. The total catch (taken predominantly by Turkey) in 2000-2005, remains ~10 th. t, similar to the pre-industrial period 1950-1975.

The catches of Black sea horse mackerel were realized by active (bathypelagic trawls and surrounding nets) and passive fishing gears (gill netting, trawl net, trap nets) (Prodanov *et al.,* 1997; Yankova *et al.,* 2010a). The Bulgarian and Romanian catches are taken primarily by passive, while the Turkish and former USSR entities by active gears (Prodanov *et al.,* 1997). The horse mackerel of age 1-3 years generally prevails in the commercial catches (Grishin *et al.,* 2007; Yankova and Raykov, 2009; Yankova *et al.,* 2010a), but strong year classes (for example, the 1969 year class) may enter into exploitation at age of 0.5 year and may prevail up to age 5-6 years (Grishin et al., 2007).The accuracy of the stock assessments depends exclusively on the fishery statistical data (Prodanov *et al.,* 1997). There are lack of information on horse mackerel catches or its underestimation by Russia, Ukraine and Georgia, Romania and Bulgaria enhances the risk of an incorrect assessment of biomasses. Over the last 40 years, highest horse mackerel catches were reported in the years preceding *Mnemiopsis leidyi* outbreak (1988-1990) (Prodanov *et al.,* 1997). The improvements of fishing gears and the application of modern echo-acoustics further contribute to a more effective fishery (Prodanov *et al.,* 1997). The same authors reported that when the level of the horse mackerel stock was low, even small catches caused higher fishing mortality, and vice verse. All this stresses the necessity of annual assessments of stock size, of TAC`s, as well as of clarifying the causes (natural and anthropogenic) determining flictuations in year class strength.

6.4.2.1.1*State of the fisheries in Turkey*

Horse mackerel stock was a subject of overfishing, resulting in a fisheries collapse in the beginning of 1990's (Ozekinei et al., 2001). The ratios of undersized individuals for horse mackerel were 89% and 92% for autumn and winter seasons, respectively. The corresponding ratios for the horse mackerel for the same seasons were 70 and 67%, respectively. Minimum allowable sizes for horse mackerel and bluefish are 13 and 20cm, respectively. The 50% cumulative values obtained trawling trials are close to those figures. But the ratios of the undersize fish of horse mackerel (< 13 cm) for the seasons of spring, autumn and winter were calculated as 93.7, 75.8 and 30.7%, respectively (Dincer *et al*., 2007).

Production of the horse mackerel, which is the second most important pelagic catch along Turkey's Black Sea coasts after the European anchovy, steadily increased until the mid-1980s and reached its maximum level of approximately 100,000 tons in 1985. The total amount of catch, however, constantly declined due to uncontrolled fishing activities and over-fishing in the 1990s and declined to 80,000 tons. Research into commercial fish stocks on Turkey's Black Sea coasts conducted during the second half of the 1980s indicated that the horse mackerel population suffered the greatest fall in terms of quantity after the sea-perch among the pelagic stocks in the past 15 years (Bingel *et a*l., 1995; Zengin *et al*., 1998a; Zengin, 2001). The breakdown of horse mackerel caught by commercial fishermen between 1991 and 1993, when the amount of horse mackerel catch started to decrease along Turkish coasts, by length confirms this conclusion. The average lengths of horse mackerel caught by large purse-seine nets and trawlers during those years were 11.1 cm, 10.9 cm and 10.6 cm, respectively (Zengin, 1998). Average operating ratio (E) calculated for the same period was 0.78 (Genç *et al.*, 1999), which clearly demonstrates the over-fishing of the horse mackerel stock. This sharp fall in the horse mackerel catch steadily increased until the end of the 1990s. The share of horse mackerel below optimal catch length (L_{opt}.= 13 cm) in the total catch caught by coastal surrounding nets in the eastern Black Sea early in the 1990s (1990-1993) was 52.2%, rose towards the end of 1990s (66.7 %) (Zengin *et al.*, 1998a, Zengin *et al.*, 2002) – Table 6.5.2.1.1.1. The length of the horse mackerel population off the southern Black Sea coast after they reach initial reproductive maturity is 11.7 cm (Genç*et al.*, 1999). A large part of immature and young individuals below the optimal catch length (*discards catch*) are taken by coastal fishermen from stock and sold on the market under the counter or destroyed on the sea. In order to eliminate this trend, which is an indicator of growth over-fishing, new fishing methods and management planning are also considered necessary for horse mackerel populations.

After the beginning of the 2000s the landings started to increased again. Total Turkish Black sea catch was up to 26.000 tons (2006 official statistics) and the average length also increased 13.7 cm. (Genç *et al*, 2006).

Horse mackerel stocks in the Black Sea are usually caught by Turkish fishermen by using active (bottom trawler, pelagic trawler and large bag-shaped nets) and passive (extension and longline) nets Table 6.5.2.1.1.1.2. Almost the whole horse mackerel catch (98.2%) is caught by large bag-shaped nets. CPUE of fishing boats using that type of net for catching horse mackerel is 3837.5 (600-10,000) kg/boat/day (Zengin *et al.*, 2003). The remaining part of the catch is caught by bottom trawler, pelagic trawler, extension net and long lines. A large part of the catch (80%) is caught in the autumn and the first part of winter (September-December) (Zengin *et al.,* 1998a) (Fig. 6.4.2.1.1.1).

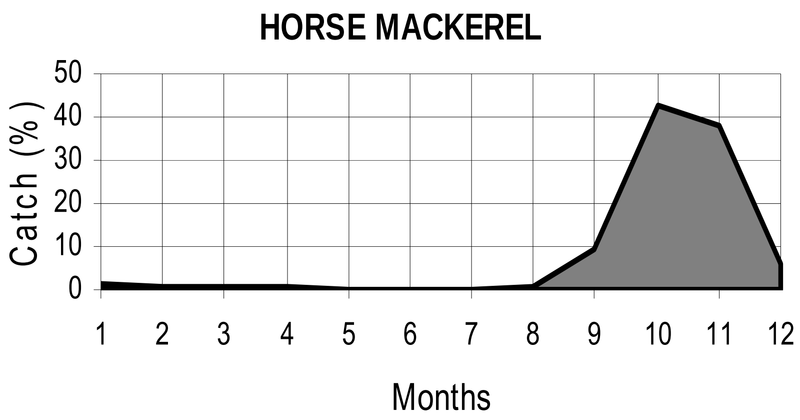


Figure 6.4.2.1.1.1. Catch distribution of the Horse mackerel in the south Black Sea by monthly.

Table 6.4.2.1.1.1. Distribution of average length (cm) and catches below the optimum catch length (L_{opt}) in the southern Black Sea in the period between 1990 and 2012.

Fishing season	**Landings (tons)**	**Optimum catch length (cm)**	**Mean weight(g)**
1990	75882	11.1	-
1991	25679	10.9	-
1992	20989	10.1	-
1993	23945	-	-

1994	25275	-	-
1995	15809	-	-
1996	16093	-	-
1997	11097	-	-
1998	8246	-	-
1999	8331	-	-
2000	16181	12.4	-
2001	16750	-	-
2002	8903	-	-
2003	9213	-	-
2004	9113	13.1	-
2005	17003	11.6	15.70
2006	25927	12.7	17.69
2007	17429	12.6	16.71
2008	20124	13.2	20.57
2009	15905	12.6	17.09
2010	12929	12.1	17.00
2011	17746	11.92	15.52
2012	23911.2	12.75	17.79

Table 6.4.2.1.1.2 % catch and catch per unit effort according to type of net in the south Black Sea in the period of between 1990 and 2000

Fish species	Parameters	Purse seine	Trawl	Pelagic trawl	Gill-nets	Set-net	Long-line
Horse mackerel	%Catch CPUE (kg/boat/day)	98.2 3837.5 (600-10000)	0.3 -	0.4 2038.7 (95.9-79.20)	0.9 -	-	0.2 -

6.4.2.1.2*State of the fisheries in Ukraine*

After a long absence, since the end of2002was renewedfishingof horse mackerelin the watersunder the jurisdiction of Ukraine.Horse mackerelforms aggregationsduring thewinteringandto a lesser extent, in the autumn onmigration routes. The Ukrainianwatersnear the Southern coast of Crimea from November to Marchitoccurwintering ground of horse mackerel. In the formation ofwinteringaggregationsof horse mackerel it possibleforfishing by lifting cone-shaped nets with electric light attraction, andpurse seines. In the warm seasonin small quantitieshorse mackerelharvestedwith poundnets, includingthe Sea of Azov. In recent years thenumberof horse mackerelmidwatertrawlis producedas by-catchin fisheriessprat. Generally, theshare of Ukrainiantotalcatchin thecatch ofmackerelin the Black Seais very low.

Upon a characterization of commercial use of the Horse mackerel stock in Ukraine, two periods clearly stand out: 1992-2001 years and since 2003 up to the present. During the first of mentioned periods Horse mackerel was practically absent as an object for Ukrainian fishing. Absence of commercial catches in the waters of the Black Sea under Ukrainian jurisdiction during 1992-2001 has an explanation in the considerable decrease of its stock number, which, in V. A. Shlyakhov and A. N. Grishin's opinion (2009), was conditioned by the negative influence of Ctenophora *Mnemiopsis*. As these authors points, the introduction of Ctenophora Beroe, that had led to decrease of negative influence of Mnemiopsis, has influenced well on the Horse mackerel stock state. Since 2003 it regains its commercial significance, and its Ukrainian catches vary on the level of several thousand tons.

Horse mackerel forms aggregations during wintering and, to lesser extent, in the autumn on migration routes. It winters in Ukrainian waters near the Southern coast of Crimea from November to March, and some years can be found from c. Takil to c. Lucull. Upon forming wintering aggregations the possibility of specialized fishing of Horse mackerel with lifting cone-shaped nets with electric light attraction appears, and, to lesser extent, of fishing with purse seines. But the aggregations of commercial character form not every year, thus the specialized fishing of Horse mackerel is carried out occasionally and only in certain years. As a rule, the most part of Horse mackerel is caught with midwater trawls as by-catch at sprat fishing. During warm seasons Horse mackerel is caught with pound nets in small amounts. Under mentioned peculiarities of distribution, the prevalent part of the Horse mackerel year catch falls on I and IV quarters. The age structure of Horse mackerel catches (Shlyakhov and all., 2012) differentiates significantly in different years, herewith the prevalence of individuals of one-two generations is characteristic in catches (Table 6.5.2.1.2.1).

Table 6.4.2.1.2.1 Age structure of horse mackerel commercial catches in the waters of the Black Sea under the jurisdiction of Ukraine during 2003-2012.

Year	Average waight (g)	Age composition (%)					
		0+	1-1+	2-2+	3-3+	4-4+	5-5+
2003	18.1	-	1	97	2	-	-
2004	29.4	1	2	6	91	0	-
2005	23.3	-	30	50	15	5	-
2006	17.4	-	67.7	13.1	18.9	0.3	-
2007	18.2	-	51.1	20.4	27.7	0.8	-
2008	17.9	0.9	24.8	63.3	10.3	0.5	0.2
2009	23.2	-	-	16.9	55.8	24.0	3.3
2010	12.8	46.4	52.8	0.8	-	-	-
2011	17.5	9.1	80.4	4.5	3.8	2.2	-
2012	14.3	30.0	8.0	50.5	11.4	-	-

Table 6.5.2.1.2.2. Horse mackerel fishing mortality (F) by Jones method (Ukrainian waters).

Year									
	2004	2005	2006	2007	2008	2009	2010	2011	2012
FL, mm									
146-150	0.243	1.340	1.826	0.532	1.194	0.499	1.299	1.370	0.638
151-155	0.280	1.049	2.099	0.624	0.638	0.373	1.199	3.841	0.184
156-160	0.342	1.177	0.843	0.637	0.547	0.357	0.720	0.342	0.211
161-165	0.463	0.479	0.463	0.742	0.903	0.186	0.463	0.463	0.256
L145-165	0.332	1.011	1.308	0.634	0.820	0,354	0,920	1.504	0.322

6.4.2.2 Management regulations applicable in 2012 and 2013

The EWG 13-12 will provide a full description of national and international regulations regulating the horse mackerel fisheries during its next meeting in 2013.

6.4.2.3 Catches

6.4.2.3.1 *Landings*

The data set of landings was compiled for the period 1950 – 2012. It is evident (Table6.5.2.3.1.1) that during the periods (1956 – 1965) the catches have continued to grow and their mean values reached – 19007. 95tons.During the period 1966 – 1975 the total average catch have increased to 21041.98tons.The next decade

(1976 – 1985) the horse mackerel catches have also increased from 20576.3to 141077.8 tons, respectively. The period 1986 – 1995 was characteristic with abrupt decline in the catches of the fish from 977408to 15906 tons. The next 7 years (1996 – 2002) represented a period of prolonged decreasing of the mean horse mackerel catch- mean values reached-12343.64 tons.

The data of Bulgarian catches show considerable fluctuations, they could be distinguished in two stages(Yankova *et al.*,2009). In the first stage from 2000 to 2003 years, relatively high amounts of catches are evident. In 1992was realized catch of 165 t. Last relatively high catch amount of 141.6 t was reported in 2003. Upon 1993 the amounts of catches suddenly dropped particularly in 1994-1999 period, when the landings fluctuated from 30 t in 1999 to 80 t in 1994. The last investigated years are characterized by a trend ofconsiderable increase of horse mackerel catches.Comparison with2007 substantially increase (round about 55%) was reported in catches of horse mackerel, which is the amount was 179.8 t for 2008(data source -official statistics of the National Agency of Fisheries and Aquaculture).

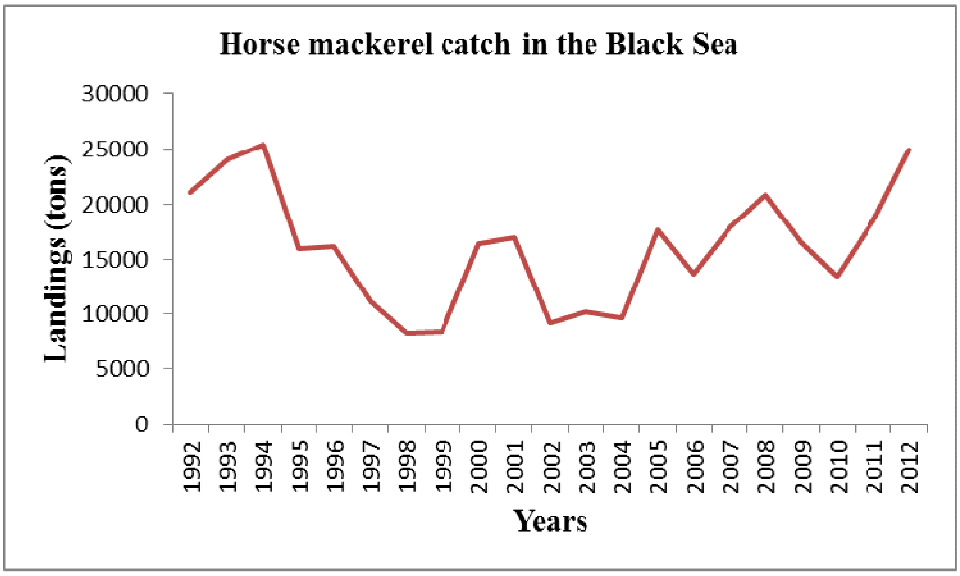
Table 6.4.2.3.1.1. Black Sea horse mackerel landings (in tonnes) by counries during the period 1950-2012.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Total
1950	644.4	-	217.0	-	1200.0	-	8291.4
1951	736.2	-	293.0	-	2500.0	-	5399.2
1952	564.9	-	260.0	-	2600.0	-	6474.9
1953	294.7	-	140.6	-	9200.0	-	22094.7
1954	593.2	-	617.8	-	12200.0	-	25511.2
1955	662.4	-	297.4	-	7200.0	-	19950.4
1956	131.5	-	63.5	-	14200.0	-	29734.5
1957	69.4	-	119.7	-	14000.0	-	26919.4
1958	233.0	-	587.4	-	4900.0	-	17370.0
1959	687.4	-	839.8	-	700.0	-	12687.4
1960	1017.7	-	674.6	-	4800.0	-	17691.7
1961	1240.6	-	2200.0	-	3600.0	-	16345.6
1962	805.2	-	1166.0	-	13500.0	-	29271.2
1963	231.4	-	532.0	-	3500.0	-	18163.4
1964	242.0	-	248.4	-	3100.0	-	13790.0
1965	301.6	-	1364.7	-	1200.0	-	8106.3
1966	556.7	-	1770.0	-	600.0	-	5276.7
1967	245.7	-	762.0	-	24615.0	-	32111.7
1968	37.4	-	175.0	-	4750.0	-	20124.4
1969	95.9	-	156.0	-	16762.0	-	18293.9
1970	689.1	-	1342.0	-	19380.0	-	22041.1
1971	630.9	-	1218.0	-	8722.0	-	14920.9
1972	534.0	-	500.0	-	10855.2	-	33709.2
1973	849.0	-	606.0	-	16593.7	-	28828.7
1974	2168.8	-	608.0	-	10244.8	-	15904.6
1975	1972.8	-	1003.0	-	11897.8	-	19208.6
1976	1808.7	-	1514.0	-	14077.9	-	35745.6
1977	791.0	-	404.0	-	14674.3	-	20576.3
1978	565.0	-	729.0	-	23529.0	-	25508.0
1979	934.5	-	1179.0	-	59772.0	-	62619.5
1980	813.0	-	1536.0	-	42339.0	-	45297.0
1981	476.2	-	588.0	-	40543.0	-	41951.2
1982	366.8	-	291.0	-	48918.0	-	51450.8
1983	496.7	-	1510.0	-	54548.0	-	63711.7
1984	1015.8	-	872.0	-	69980.0	-	77369.8
1985	755.8	-	1035.0	-	100417.0	-	141077.8
1986	850.9	-	945.0	-	100943.0	-	105108.9
1987	826.4	-	997.0	-	90850.0	-	93216.4

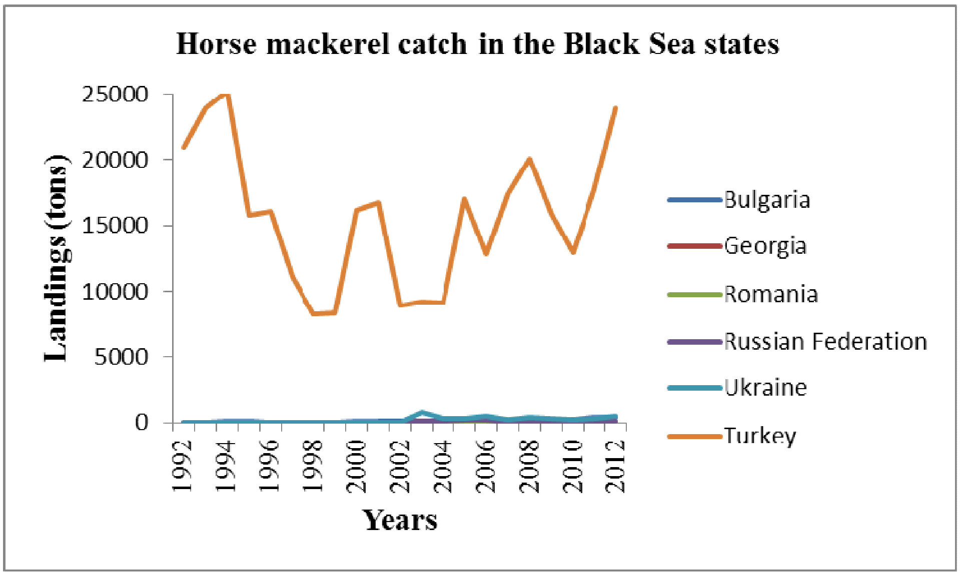
1988	1676.8	-	2660.0	-	93006.0	-	977408
1989	1100.9	-	1459.0	-	94023.0	-	96887.9
1990	164.1	-	165.0	-	65163.0	-	65548.1
1991	122.9	48.0	0	-	19781.0	-	19954.9
1992	54	0	22	0	20989	0	21065
1993	31	0	30	0	23945	0	24006
1994	80	0	35	1	25275	1	25392
1995	70	0	24	1	15809	2	15906
1996	68	0	10	0	16093	0	16171
1997	36	18	1	0	11097	5	11157
1998	40	13	15	2	8246	0	8316
1999	30	0	3	2	8331	1	8367.2
2000	111	35	8	2	16181	0	16336.8
2001	130	7	17	6	16750	1	16911
2002	141.5	19	21	28	8903	34	9146.5
2003	141.6	70	10	77	9213	745	10256,6
2004	73.9	56	14	105	9113	272	9633.9
2005	29.4	60	12	169	17003	329	17602.4
2006	62.834	55	19	200.5	12812	476	13625.33
2007	115.88	53	14	63.2	17429	211	17886.08
2008	179.607	8	11	154.24	20124	366	20842.85
2009	176.91	6*	17	124.04	15905	260	16489.06
2010	165.27	5*	7	108.86	12929	190	13405.50
2011	394.84	44**	22.820	87.21	17746	264	18558.87
2012	381.37	44	20.005	69.50	23911.2	539.713	24931.36

Remark: * expert assessments;** oral announcementin meeting AG FOMLR/BSCommission 2011

In 1992 a catch of 21065 twas caught. Upon 1994 the amounts of catches decreased especially in 1998-1999 period. In 2012 considerably increase in catches of horse mackerel was reported, at the level of 24931.36t (Figure 6.4.2.3.1.1A).



A.



B.

Figure 6.4.2.3.1.1 Trend in total (A) and by countries (B) horse mackerel landings in the Black Sea.

6.4.2.3.2*Discards*

No discards have been reported for the horse mackerel fishery.

6.4.2.4 Fishing effort

No information has been tabled during the EWG 13-12 meeting.

6.4.2.5 Commercial CPUE

Table 6.4.2.5.1. CPUE kg/h of horse mackerel by fishing gears in Bulgaria, during the period 2008-2012.

Mediterranean horse mackerel HMM			**2008**	**2009**	**2010**	**2011**	**2012**
	FPO	LOA>0<6	344.98	101.56	51.22	123.92	83.62
		LOA=>6<12	130.4	97.62	77.67	40.96	131.12
		LOA=>12<18	209.73	43.33	-	-	-
	OTM	LOA=>6<12	149.8	95.54	105.28	50.28	51.63
		LOA=>12<18	273.78	112.44	202.42	240.01	126.74
		LOA=>18<24	456.47	294.84	321.25	272.91	192.1
		LOA=>24<40	268.4	279.61	293.23	1121.39	588.05

Legend:FPO–Pound nets/Pots; OTM– Midwater otter trawl; LOA – Length overall of the fishing vessels.

Table 6.4.2.5.2. Average CPUE kg/h of horse mackerel in Bulgaria, during the period 2008-2009.

Fleet Segment	LOA>0<6		LOA=>6<12		LOA=>12<18		LOA=>18<24		LOA=>24<40	
Average CPUE	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Mediterranean horse mackerel HMM	94.74	36.98	92.99	49.12	258.88	65.02	458.73	308.69	262.79	282.17

6.4.3 *Scientific Surveys*

No specific fisheries independent scientific surveys have been conducted.

6.4.4 *Assessment of historic parameters*

6.4.4.1 Method 1: Separable VPA with varying terminal Fs (0.4, 0.8 and 1.2)

6.4.4.1.1*Justification*

STECF EWG 10-02 found out that data available in different national databases would allow performing a quantitative assessment of this stock. Data from the Turkish fisheries (~95% of the catch) will be very important but horse mackerel fisheries are quite important for rest of the Black Sea countries especially when the stock is high that assures a regular strong migration in the northern Black Sea. Catch effort and biological data (age and individual size and growth) were thoroughly compiled.

Table 6.4.4.1.1.1. Data availability by countries.

Type of data	Turkey	Romania	Bulgaria	Ukraine	Comment
Catch (monthly, quarterly, yearly)	yes	yes, monthly, 2006-2008	the end year 2008	the end year 2010	
IUU catches	only can be estimated	no	the end year 2008	no	expert est.: low level (not more then 10-15%)
Fishing gears	yes	yes	the end year 2008	yes	trawls (by-catch), lift cone-shaped nets with electric light attraction, pound nets
Fishing seasons	yes	yes	the end year 2008	yes	trawls: November-March; Lift cone-shaped nets: December-February; Pound nets: June-September
Fishing areas	yes	yes	the end year 2008	yes	trawls & lift cone-shaped nets: Crimean waters; pound nets: Crimean & NW of Black Sea coastal waters, Crimean of Azov Sea coastal waters
Fishing and natural mortality estimations	yes	yes	no	2004-2009	
Mean individual weights	yes	yes	the end year 2008	2011	2003-2008
Catch-at-age	yes	yes		2004-2011	
Length and weight at age	yes	yes	yes	2011	
CPUE from commercial yield and surveys	indirectly		no	no	
Migration routes (spawning,fattening,wintering grounds)	indirectly	yes	yes	yes	
Existing fishery regulations in country	yes	yes	yes	yes	
Existing analyses for 1950-2009	some years; 1990-1993	yes	yes	yes	in Turkey they are some poulation parametrs diffrent yeras, diffrent area and institution

6.4.4.1.2*Input parameters*

Catch at age

Table 6.4.4.1.2.1. Aggregated catch at age in number 10^{-3} of Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine during the period 2004-2012.

Age Year	0	1	2	3	4	5	6
2004	4031.8001	8552.65319	23888.61439	351197.871	486.8652502	170.3480528	20.41601383
2005	24623.8	446026.448	510230.8371	117165.337	15977.07681	2078.610163	54.25073633
2006	7149.7177	289385.028	381781.7543	68877.6232	19612.52778	2295.03876	554.5081117
2007	596.92757	633607.85	364748.1832	61099.7537	5731.807176	2740.416069	0
2008	6678.3366	189996.56	556876.1004	232242.597	27287.16785	2573.869748	26.64733206
2009	3910.7335	395249.709	421199.273	92146.0061	37179.53485	6013.341588	998.3546439
2010	28029.157	300248.161	334444.5576	128585.373	55875.03503	18165.18663	6057.42282
2011	29325.467	715934.213	272264.7989	134564.125	23781.84854	7464.849154	3072.334567
2012	20740.433	692427.992	633694.9337	55724.1519	6778.735012	1088.402902	87.96761201

Weight at age in the catch

Table 6.4.4.1.2.2 Weight at age in the catch (W-mean weight fish in catches, in g).

Age Year	0	1	2	3	4	5	6	W
2004	8.61	12.51	14.15	25.86	30.58	39.46	43.41	24.81
2005	4.24	13.23	20.62	29.72	38.62	45.84	43.56	15.77
2006	4.94	13.77	21.19	29.34	42.06	51.82	57.20	17.70
2007	9.66	14.70	20.10	29.19	36.97	42.72		16.74
2008	4.79	12.66	23.07	30.28	39.00	50.90	41.25	20.52
2009	5.19	13.01	20.69	30.22	42.54	50.12	67.44	17.24
2010	4.37	10.05	21.85	28.46	31.43	36.81	63.36	15.38
2011	5.43	13.01	24.79	37.89	51.42	65.63	73.17	15.64
2012	6.52	14.39	23.18	33.49	34.62	49.41	39.88	17.68

Table 6.4.4.1.2.3 Horse mackerel maturity at age.

Age Year	0	1	2	3	4	5	6
2004	0	0.8	1	1	1	1	1
2005	0	0.8	1	1	1	1	1
2006	0	0.8	1	1	1	1	1
2007	0	0.8	1	1	1	1	1
2008	0	0.8	1	1	1	1	1
2009	0	0.8	1	1	1	1	1
2010	0	0.8	1	1	1	1	1
2011	0	0.8	1	1	1	1	1
2012	0	0.8	1	1	1	1	1

A new tuning series from a commercial CPUE from Bulgaria (Table 6.4.4.1.2.4), not available for EWG 11-16, was available for this meeting(EWG 13-12) and has been used to tune an XSA model.

Table 6.4.4.1.2.4 Tuning fleet data from Bulgarian commercial CPUE.

Age Year	0	1	2	3	4	5	6
2008	394.332	3656.533	4463.121	3082.959	2599.006	824.5124	53.7725
2009	1018.096	2923.245	1790.908	2513.319	2452.838	1118.897	57.121
2010	979.2468	4194.011	5527.591	2570.523	1597.719	141.7331	19.327
2011	3289.893	9213.472	11705.28	5595.478	1108.454	248.2938	70.941
2012	936.804	4064.776	3726.045	4212.972	3382.021	248.7559	89.976

Table 6.4.4.1.2.5 Natural mortality matrix for Horse Mackrel in Black Sea.

Age Year	0	1	2	3	4	5	6
2004	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2005	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2006	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2007	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2008	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2009	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2010	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2011	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2012	0.4	0.4	0.4	0.4	0.4	0.4	0.4

6.4.4.2 Method 2: XSA

6.4.4.2.1 *Justification*

Given the availability of a tuning fleet of commercial CPUE from Bulgaria for years 2008-2012 an XSA(in FLR) was attempted.

6.4.4.2.2 *Input data*

Input data have been described in previous sections and are the same for the XSA and separable VPA. A first step taken before the XSA was to correct the catch at age data to the official landings (SOP corrections) since there where clear discrepancies.

An average natural mortality (M) of 0.4 is applied in all ages and years.

The XSA was tuned with the series of CPUE from Bulgaria, ages 1-6+ over the period 2004- 2012.

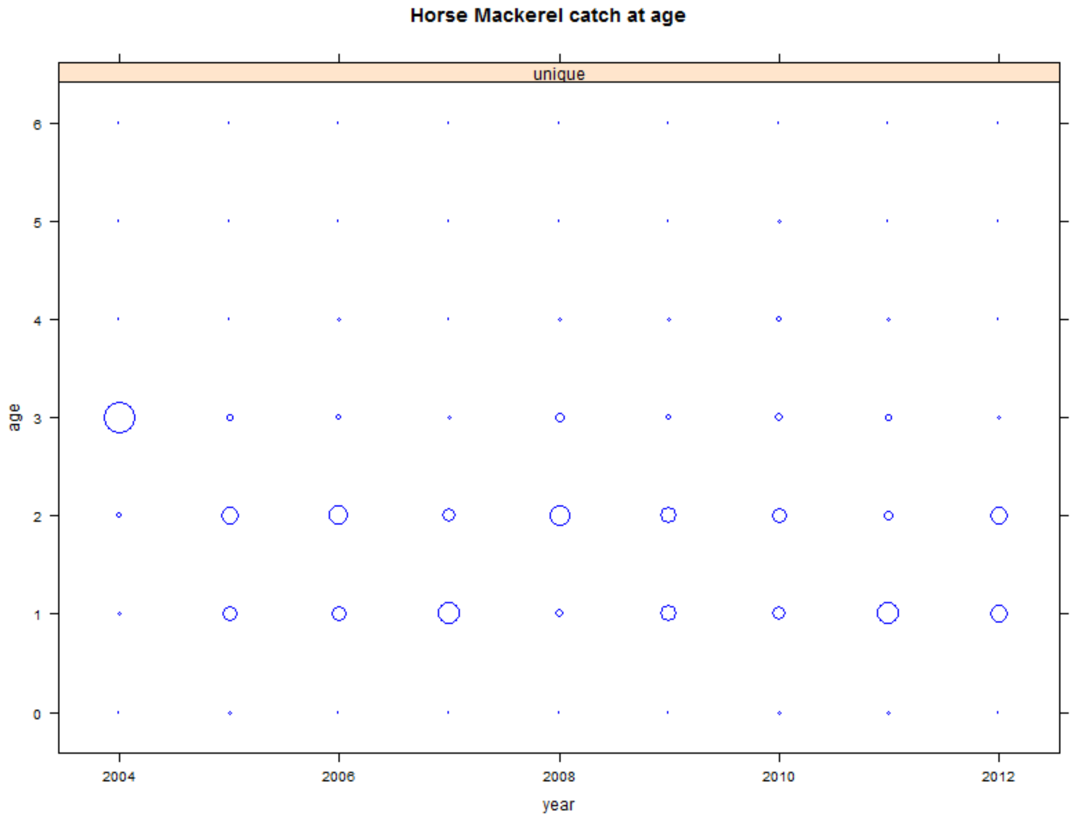


Figure 6.4.4.2.1 Horse mackerel catch at age in the Black Sea 2004-2012.

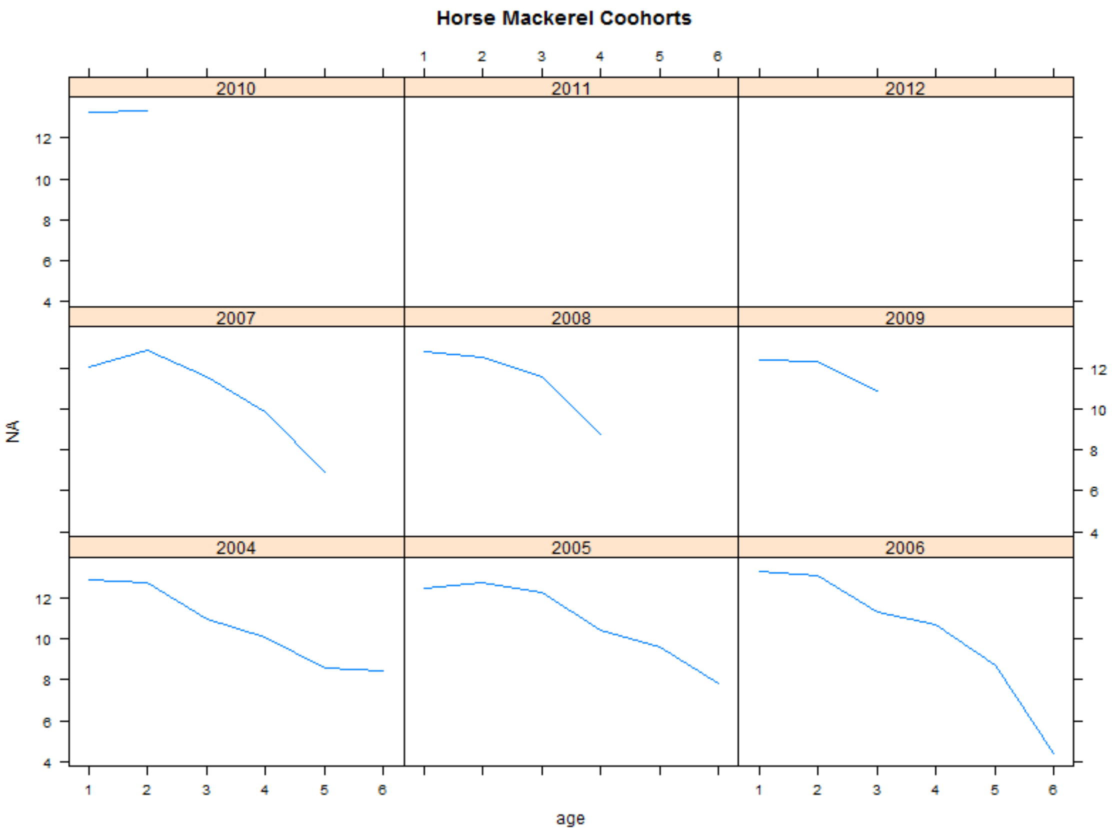


Figure 6.4.4.2.2 Cohorts for age 1-6 by year from catch numbers at age.

6.4.4.3 Results

3 different XSA where run with varying settings for the shrinkage in the fishing mortality standard error for 2 years and age 2 as follows in R code:

```
FLXSA.control.hma <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3,
fse=0.5,rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2, window=100,
tsrange=20, tspower=3, vpa=FALSE)

FLXSA.control.hma1 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.0,
rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2, window=100, tsrange=20,
tspower=3, vpa=FALSE)

FLXSA.control.hma2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.0,
rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2, window=100, tsrange=20,
tspower=3, vpa=FALSE)
```

STECF EWG 13-12 accomplished analysis of residuals of Bulgarian tuning series for different shrinkage settings Fig.6.4.4.3.1-6.4.4.3.3. The residuals with intermediate shrinkage of 1 seem the best ones Fig. 6.4.4.3.2.

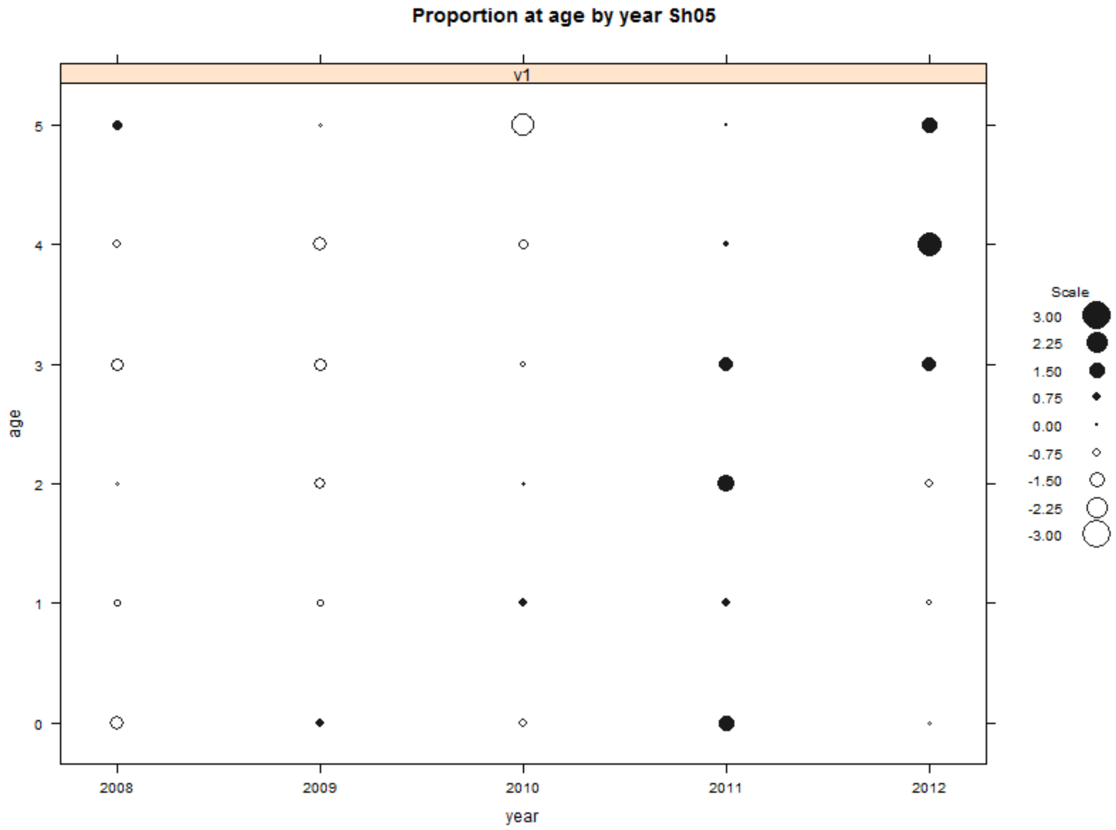


Figure 6.4.4.3.1 Residuals of tuning series applying a shrinkage of 0.5.

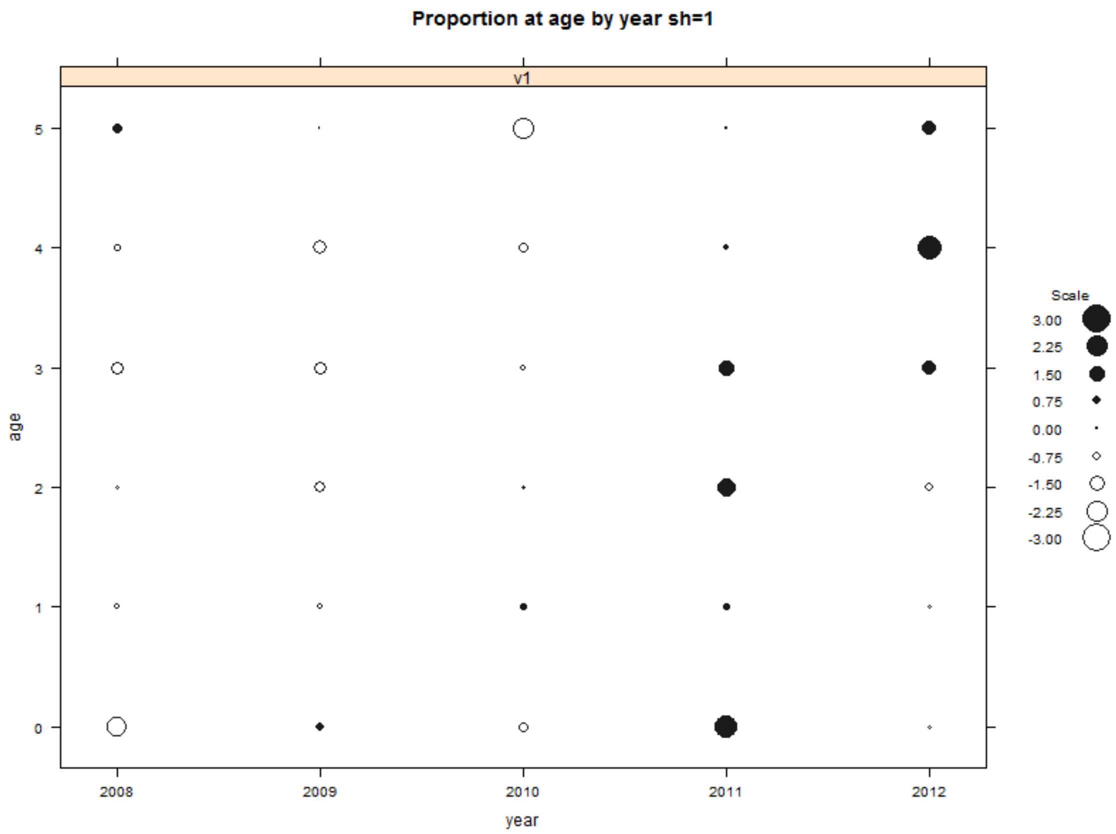


Figure 6.4.4.3.2 Residuals of tuning series applying a shrinkage of 1.0.

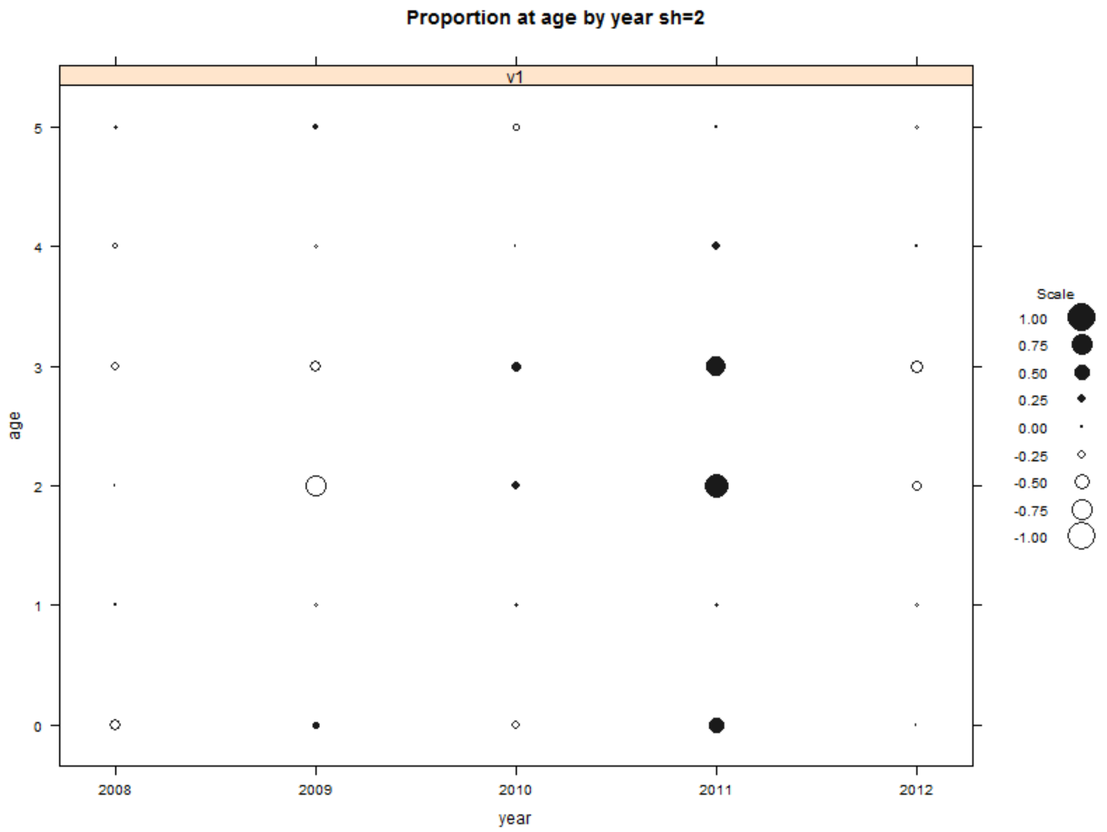


Figure 6.4.4.3.3. Residuals of tuning series applying a shrinkage of 2.0.

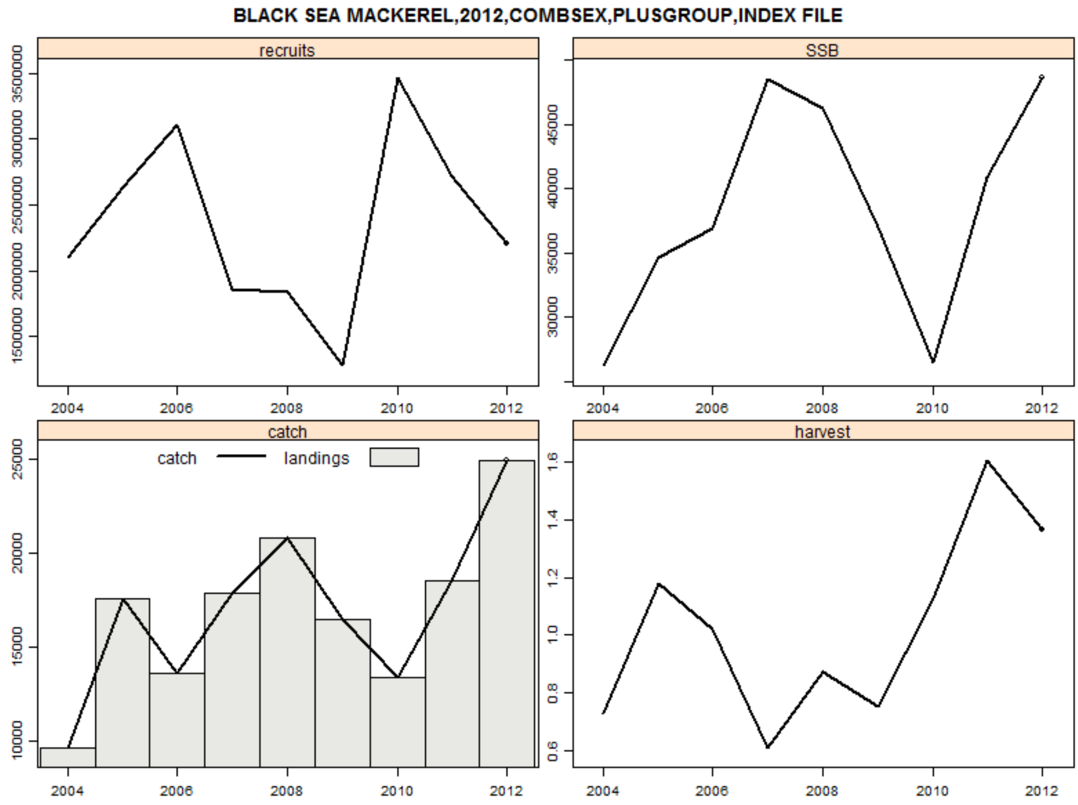


Figure 6.4.4.3.4 Summary of trends in stock parameters of Horse mackerel in the Black Sea with a shrinkage of 1.

XSA diagnostics for model run with shrinkage = 1 are summarized below:

```
FLR XSA Diagnostics 2013-10-04 09:14:33

CPUE data from indices

Catch data for 9 years 2004 to 2012. Ages 0 to 6.


fleet first age last age first year last year alpha beta

1 Commercial CPUE Bulgaria         0        5       2008       2012   <NA><NA>

<NA>

Time series weights:

 Tapered time weighting applied
   Power =    3 over   20 years

 Catchability analysis :

     Catchability independent of size for ages >  1
     Catchability independent of age for ages >   5

 Terminal population estimation :

     Survivor estimates shrunk towards the mean F
```

of the final 2 years or the 2 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012
all	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.002	0.010	0.003	0.000	0.004	0.003	0.008	0.011	0.011
1	0.010	0.400	0.201	0.439	0.180	0.427	0.415	0.361	0.569
2	0.111	1.551	1.098	0.585	1.112	1.059	0.918	1.207	1.097
3	2.669	1.292	1.585	0.701	1.211	0.700	1.457	2.395	1.767
4	0.132	1.469	1.204	0.712	0.993	0.826	1.718	2.457	2.032
5	1.439	1.419	1.433	0.722	1.039	0.818	1.817	2.505	1.864
6	1.439	1.419	1.433	0.722	1.039	0.818	1.817	2.505	1.864

XSA population number (Thousand)

year \ age	0	1	2	3	4	5	6
2004	2099875	1012582	279360	463296	4842	274	31
2005	2635494	1404270	671715	167601	21529	2845	71
2006	3107687	1749500	631127	95431	30865	3320	761
2007	1860701	2077865	959027	141129	13106	6207	2
2008	1844812	1246799	898346	358193	46917	4312	43
2009	1280481	1231767	697864	198025	71554	11646	1870
2010	3460089	855495	538988	162279	65903	20996	6574
2011	2717448	2301181	378645	144296	25349	7922	3008
2012	2206901	1802402	1074824	75949	8817	1456	110

Estimated population abundance at 1st Jan 2013

year \ age	0	1	2	3	4	5	6
2013	236633	1463618	683669	240449	8699	775	151

Fleet: Commercial CPUE Bulgaria
Log catchability residuals.

age \ year	2008	2009	2010	2011	2012
0	-1.766	0.706	-0.792	2.050	-0.234
1	-0.393	-0.422	0.558	0.467	-0.221
2	-0.283	-0.986	0.288	1.620	-0.654
3	-1.114	-1.128	-0.310	1.326	1.188
4	-0.567	-1.179	-0.821	0.352	2.187
5	0.743	-0.119	-1.987	0.091	1.282

Regression statistics
Ages with q dependent on year class strength
[1] "1.43369208632895" "1.22965262036694" "4.1689915934504"
"3.0645869000942"

```
Terminal year survivor and F summaries:

 ,Age 0 Year class =2012

source
                          scaledWts survivors yrcls
Commercial CPUE Bulgaria      0.057   1243438  2012
fshk                          0.096   1683951  2012
nshk                          0.848   1456459  2012

Age 1 Year class =2011

source
                          scaledWts survivors yrcls
Commercial CPUE Bulgaria      0.699    570993  2011
fshk                          0.301   1084572  2011

Age 2 Year class =2010

source
                          scaledWts survivors yrcls
Commercial CPUE Bulgaria      0.209    124963  2010
fshk                          0.791    243441  2010

Age 3 Year class =2009

source
                          scaledWts survivors yrcls
Commercial CPUE Bulgaria      0.089     28542  2009
fshk                          0.911      6742  2009

Age 4 Year class =2008

source
                          scaledWts survivors yrcls
Commercial CPUE Bulgaria      0.056      6906  2008
fshk                          0.944       677  2008

Age 5 Year class =2007

source
                          scaledWts survivors yrcls
Commercial CPUE Bulgaria      0.077       545  2007
fshk                          0.923       136  2007
```

EWG 13-12 performed a sensitivity analysis for different shrinkage settings, results are presented in Fig. 6.4.4.3.5-6.4.4.3.7. Low shrinkage returns lower estimates of spawning biomass and higher Fbar when we bring into comparison different XSAs(Fig. 6.4.4.3.5-6.4.4.3.7.).

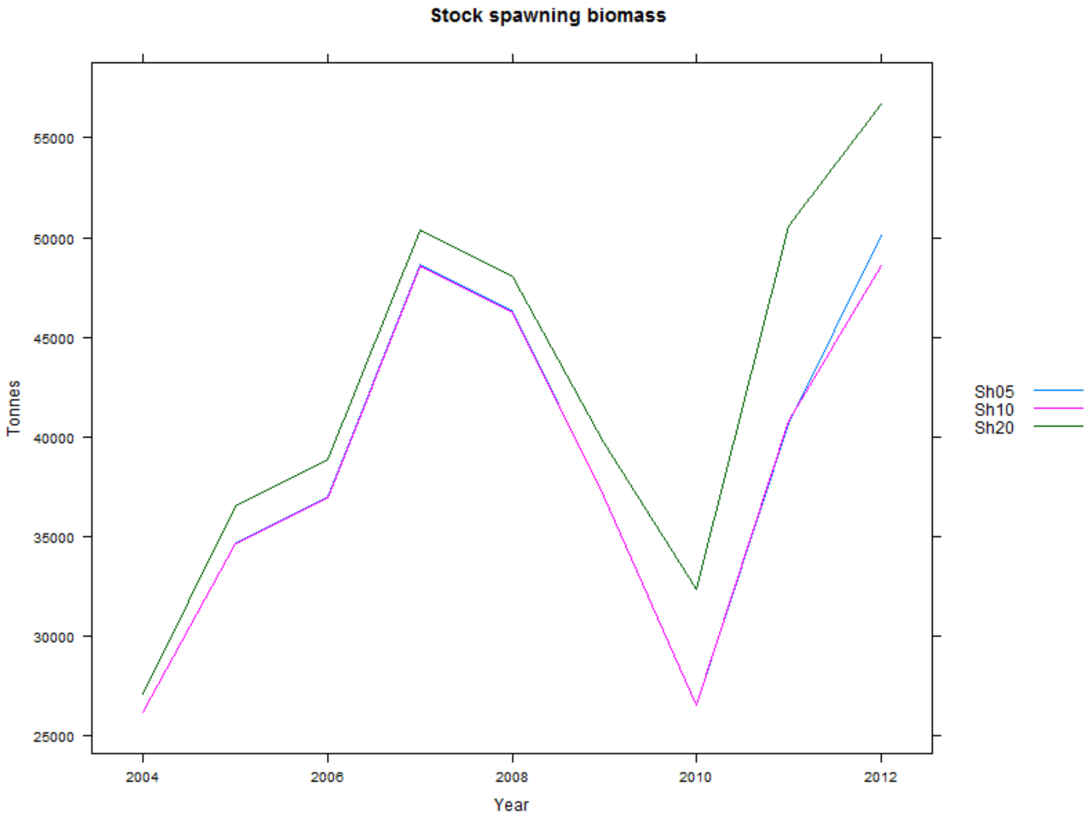


Figure 6.4.4.3.5 Sensitivity analysis on Stock spawning biomass for different levels of shrinkage.

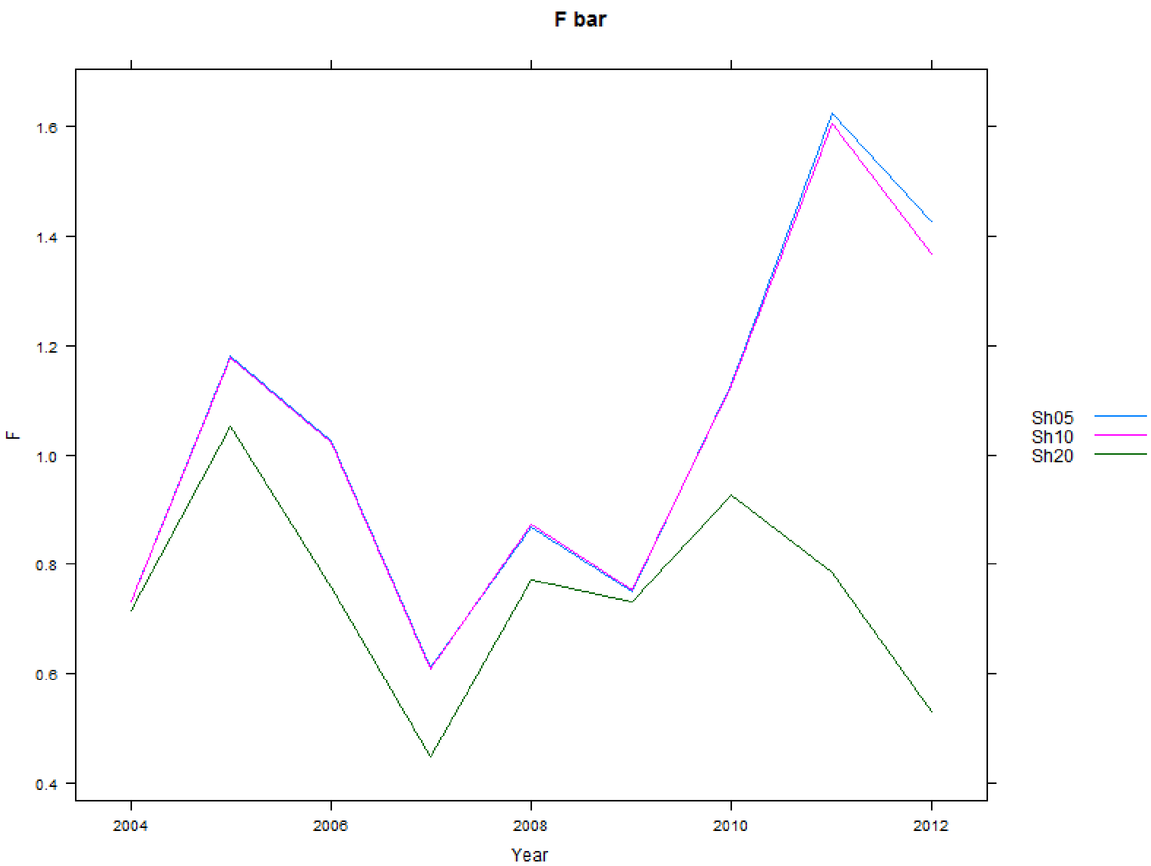


Figure 6.4.4.3.6 Sensitivity analysis on Fbar (Ages 1-3) for different levels of shrinkage.

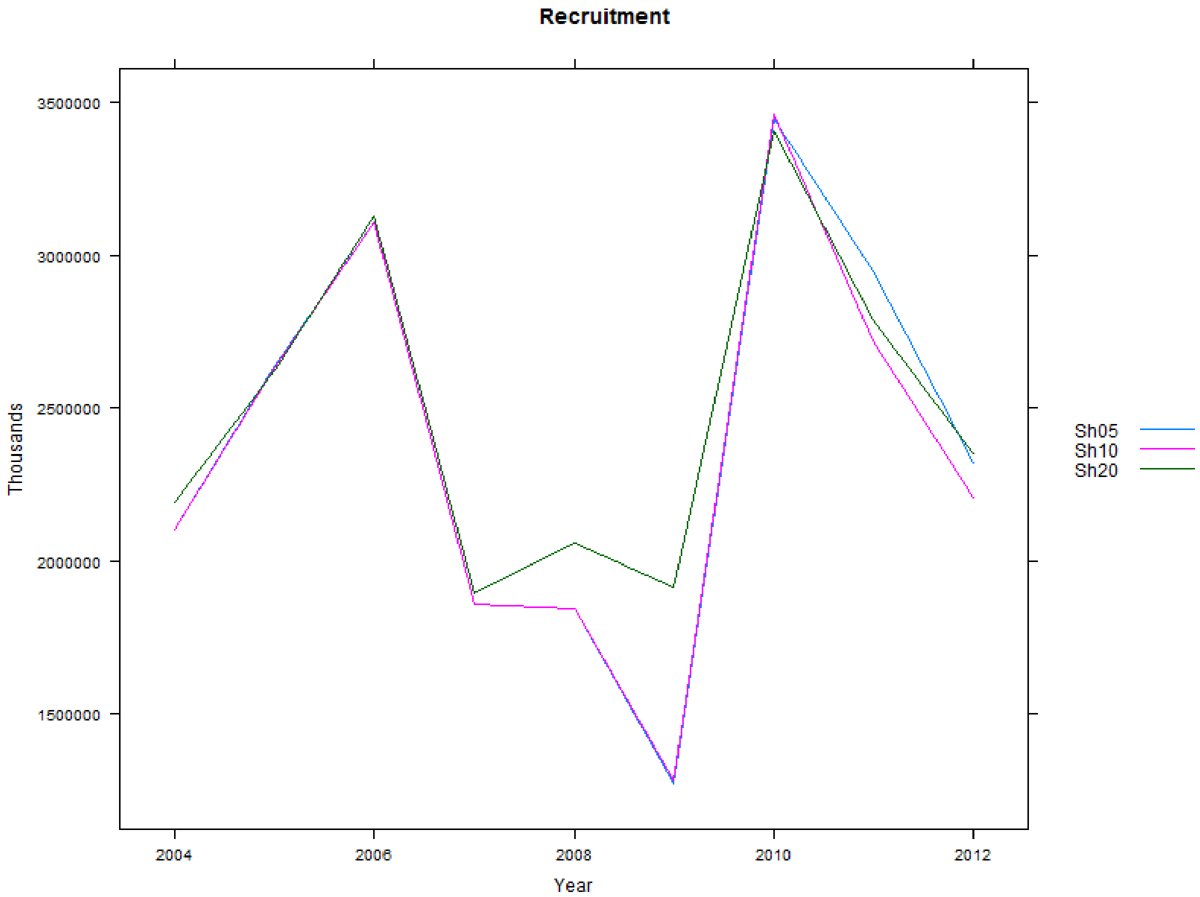


Figure 6.4.4.3.7 Sensitivity analysis on Recruitment for different levels of shrinkage.

Retrospective Analysis

The STECF EWG 13-12 Black Sea applied the Extended Survivors Analysis (XSA) under FLR and the technique “shrinkage to the mean” for assessing the stock of Horse mackerel over the period 2004-2012. The tuning of XSA is defined according to the default settings of the program.

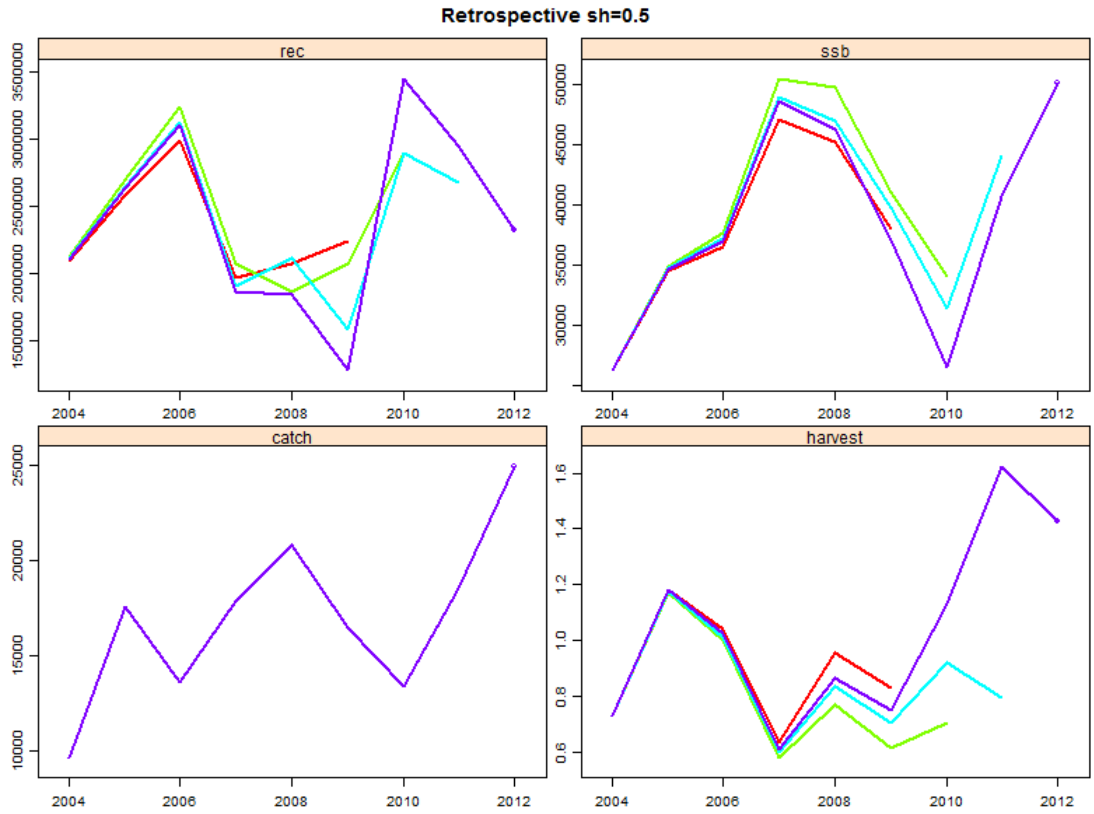


Figure 6.4.4.3.8 Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB , catch and harvest for shrinkage 0.5.

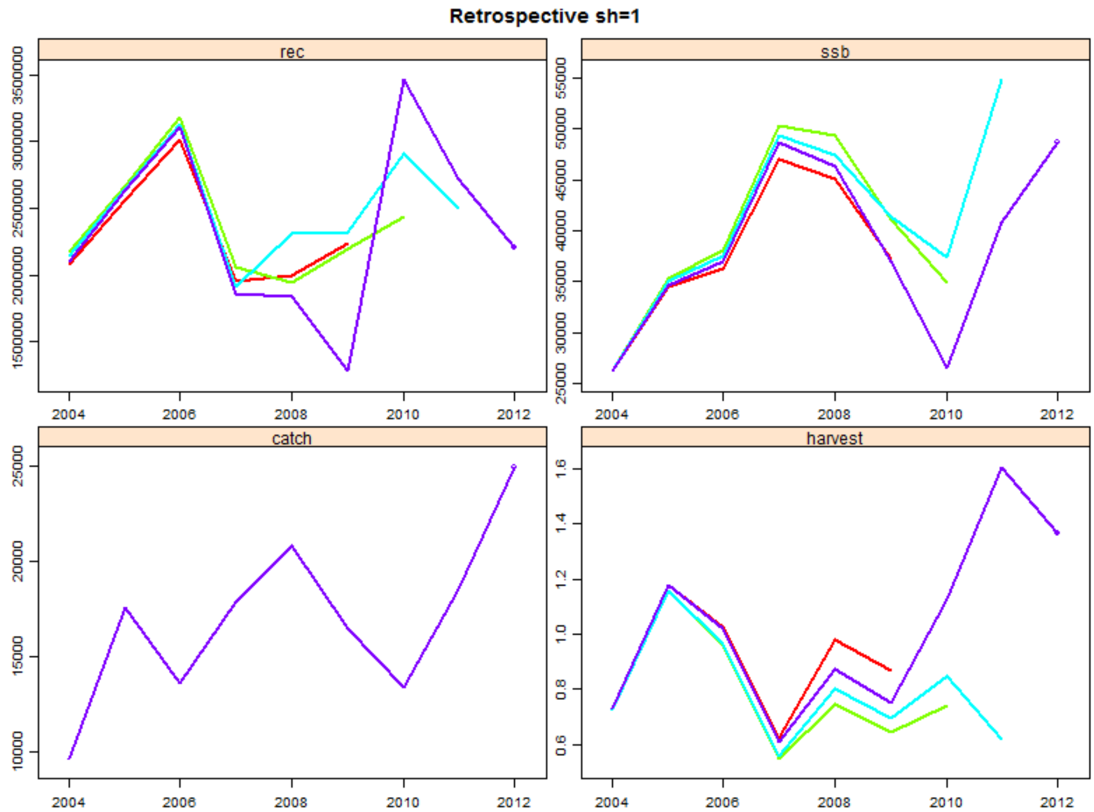


Figure 6.4.4.3.9 Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB , catch and harvest for shrinkage=1.

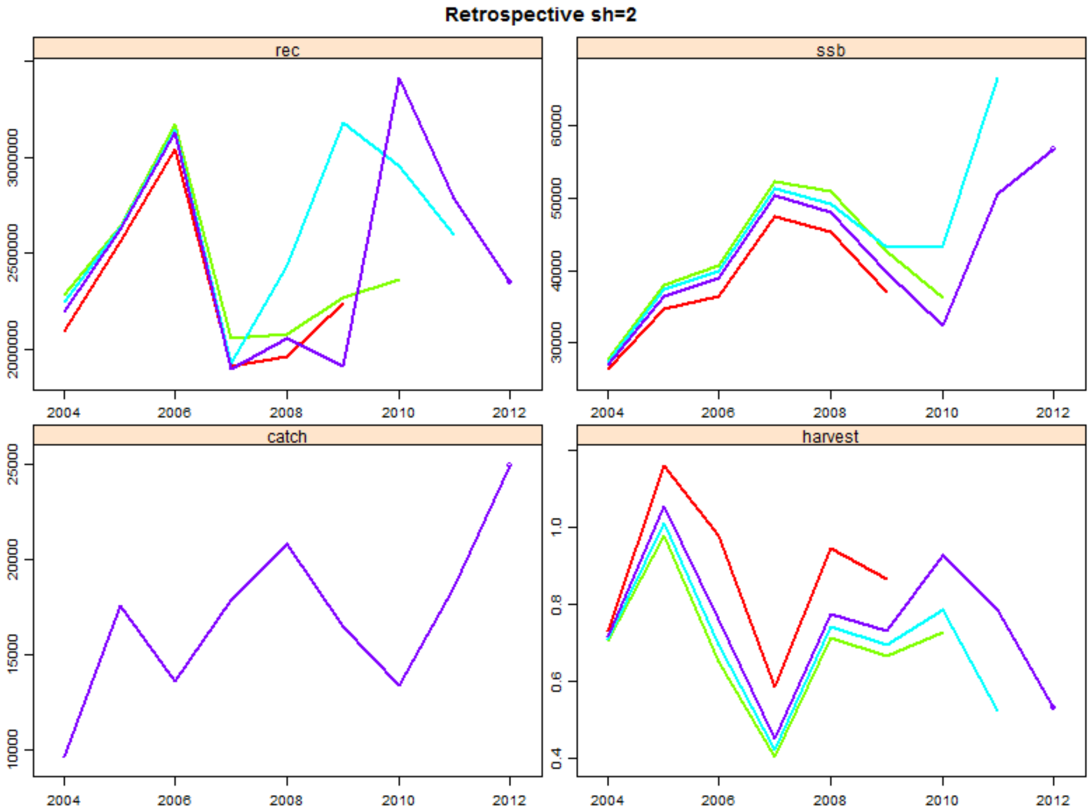


Figure 6.4.4.3.10 Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage=2.

EWG 13-12 deemed the result of XSA not reliable because of non acceptable residual patterns and retrospective patterns that are unsatisfactory. Additionally the main reason for not accepting the current XSA assessmentis because the tuning fleet from commercialCPUE from Bulgaria is not considered reliable and is deemed inappropriate for tuning the bulck of thecatches coming from the Turkish series. The XSA analysis is therefore not retained by EW13-12, which stresses the urgent need of having in the nearfuture the availability of an appropriate tuning fleet from a pelagic scientific survey carried out in the Black Sea and including Turkish waters.

6.4.4.4 Method 3: Separable VPA with varying terminal Fs (0.4, 0.8 and 1.2)

6.4.4.4.1 *Justification*

STECF EWG 10-02 found out that data available in different national databases would allow performing a quantitative assessment of this stock. Data from the Turkish fisheries (~95% of the catch) will be very important but horse mackerel fisheries are quite important for rest of the Black Sea countries especially when the stock is high that assures a regular strong migration in the northern Black Sea. Fisheries and biological (age and individual size and growth) and survey data (acoustics, juveniles, and egg-production) from all countries need to be thoroughly compiled.

At the first stage data must be carefully screened and organised into age structured matrices. Age structured assessment methods such as VPA (XSA) and ICA than can be applied similar to sprat and turbot.

The lack of any reliable tuning series to estimate terminal fishing mortalies in 2012, the EWG 13-12 (similarly to EWG 11-16 and EWG 12-16) decided to run 3 versions of separable VPAs with F=0.4, F=0.8 and F=1.2 as arbitrary inputs, respectively. This range has been chosen after a review of the results obtained from the Jones method (Table 6.4.2.1.2.2).

All the input parameters used for the separable VPA are the same, with the exception of the tuning fleet, to those used for the XSA and described above.

6.4.4.4.2*Results*

The following results are derived from the separable VPA based on a terminal F=0.4.

Separable VPA

```
ctrl <- FLSepVPA.control(sep.nyr=7,sep.age=3,sep.sel=1)

hma.stk.svpa  <- SepVPA(hma.stk,ctrl,fit.plusgroup=TRUE, ref.harvest=0.4)

hma.stk.svpa1 <- SepVPA(hma.stk,ctrl,fit.plusgroup=TRUE, ref.harvest=0.8)

hma.stk.svpa2 <- SepVPA(hma.stk,ctrl,fit.plusgroup=TRUE, ref.harvest=1.2)
```

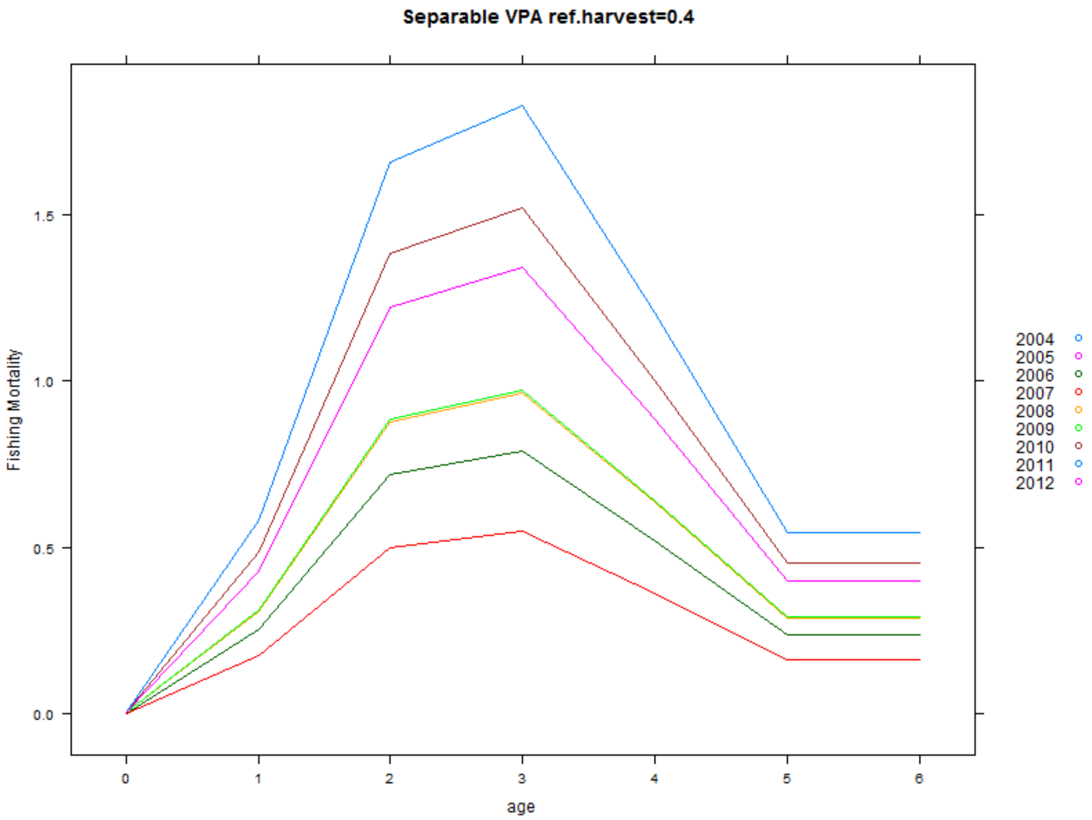


Figure 6.4.4.4.2.1Selection patterns as derived from the separable VPA with F terminal of 0.4.

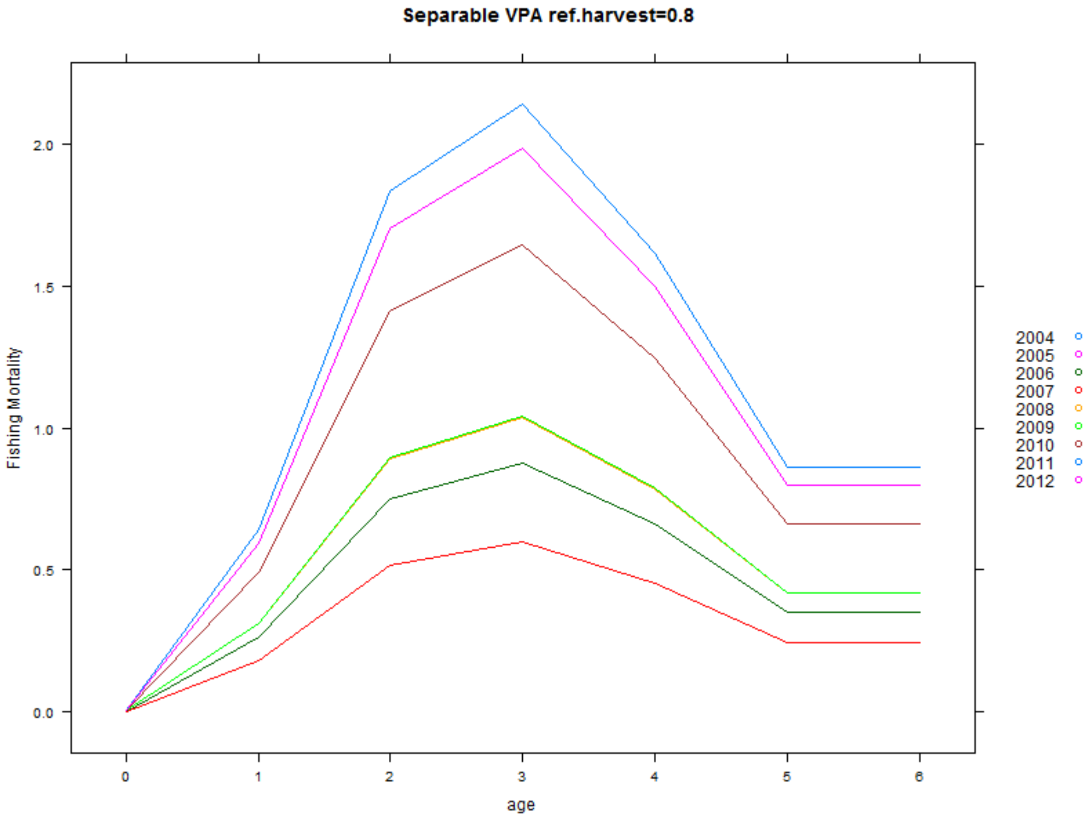


Figure 6.4.4.4.2.2Selection patterns as derived from the separable VPA with F terminal of 0.8.

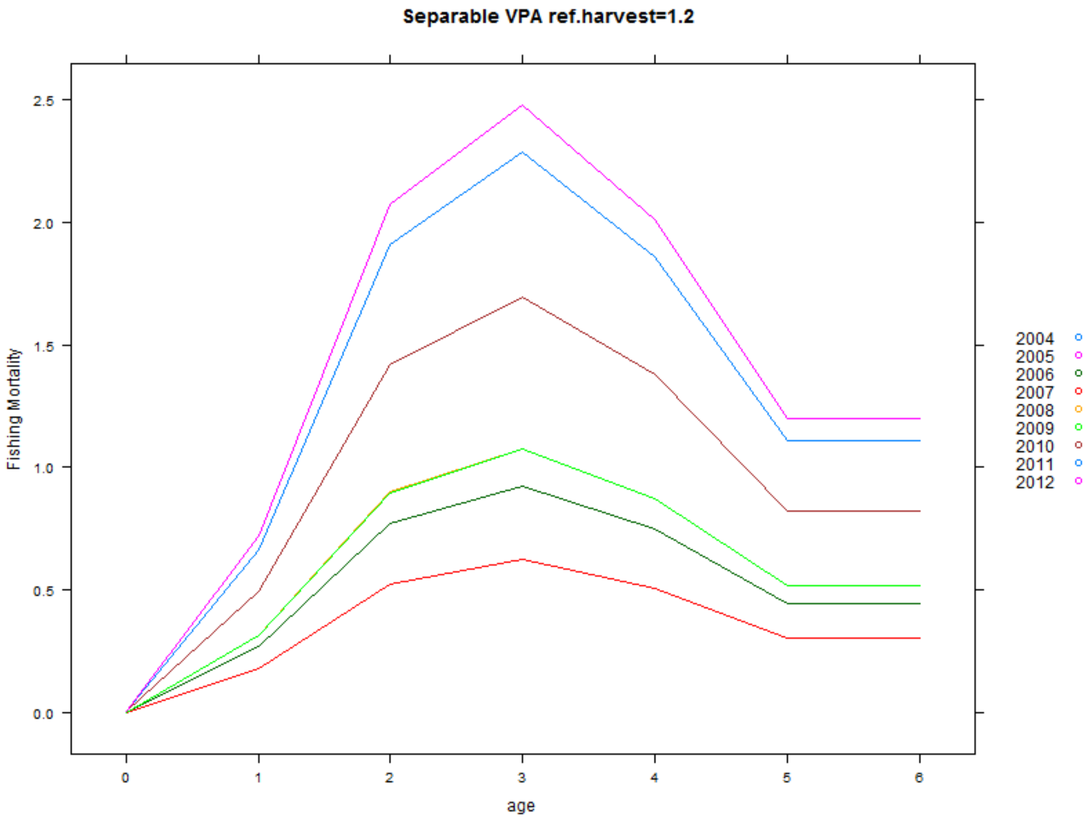


Figure 6.4.4.4.2.3Selection patterns as derived from the separable VPA with F terminal of 1.2.

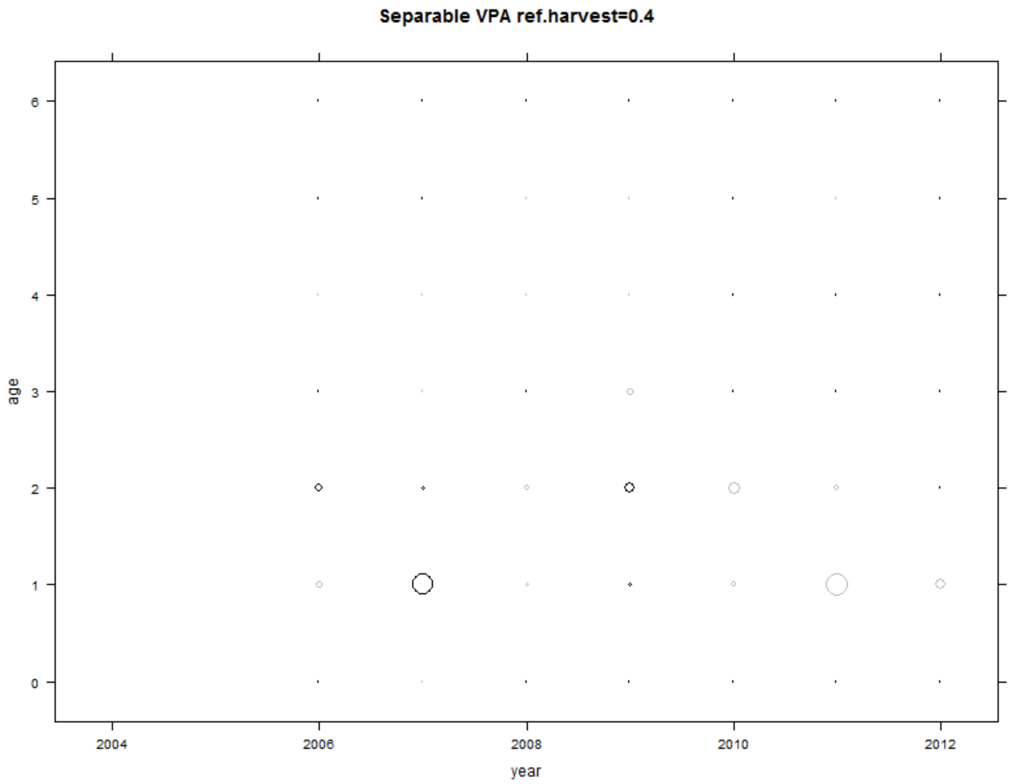


Figure 6.4.4.4.2.4Residuals in estimated fishing mortalies with F terminal of 0.4.

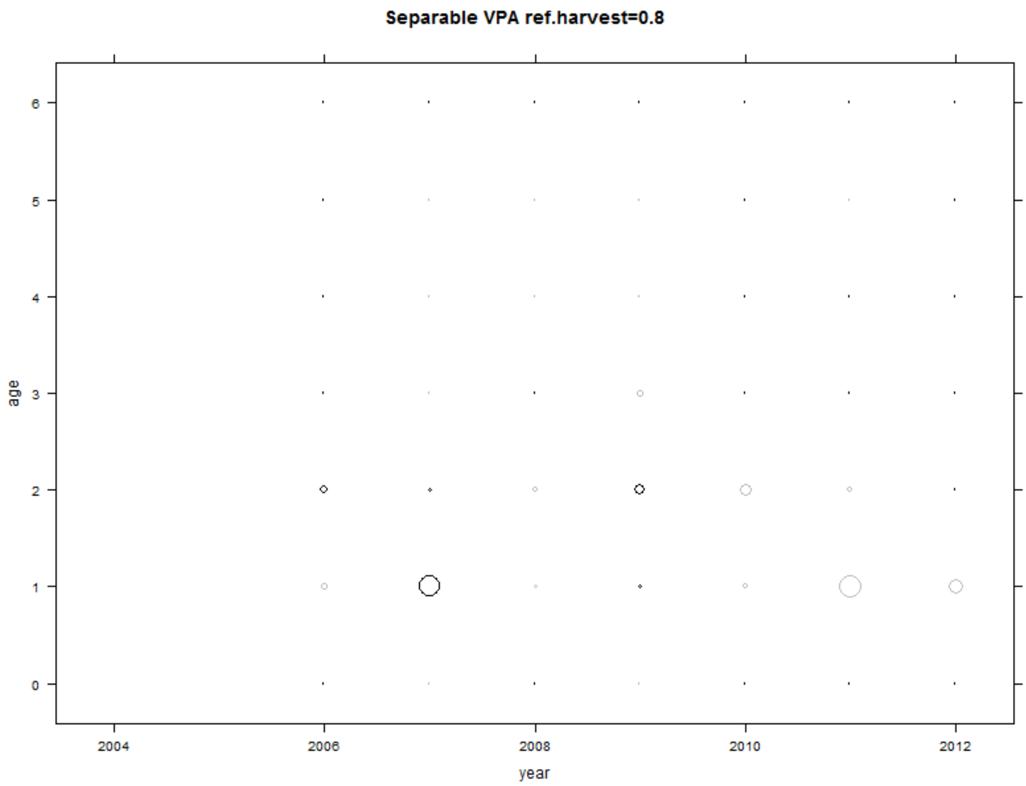


Figure 6.4.4.4.2.5Residuals in estimated fishing mortalies with F terminal of 0.8.

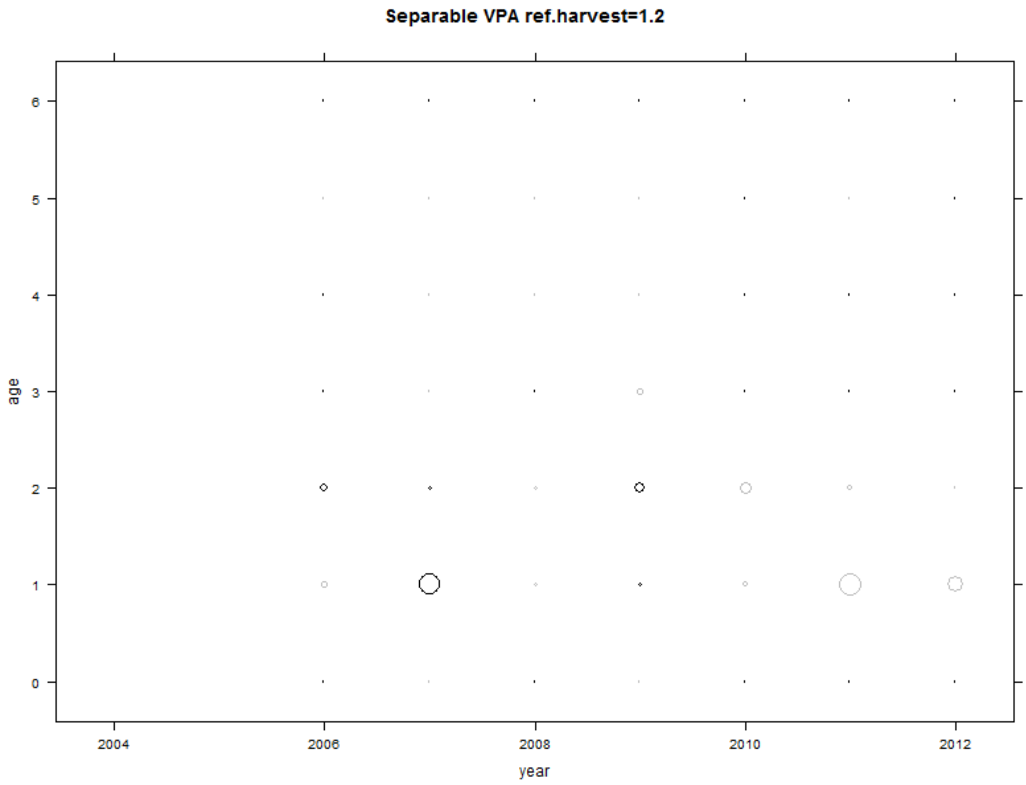


Figure 6.4.4.4.2.6 Residuals in estimated fishing mortalies with F terminal of 1.2.

6.4.5 *Short term prediction of stock biomass and catch*

The current state of the assessment does not allow any reliable formulation of a short term prediction of stock size and biomass under various management scenarios.

6.4.6 *Medium term prediction of stock biomass and catch*

The current state of the assessment does not allow any reliable formulation of a medium term prediction of stock size and biomass under various management scenarios.

6.4.7 *Long term predictions*

The current state of the assessment does not allow any reliable formulation of a long term prediction of stock size and biomass to conclude on biological reference points consistent with high long term yields.

6.4.8 *Scientific advice*

The lack of a fishery independent scientific survey to monitor horse mackerel all over the Black Sea to indicate trends in total mortality and recruitment appears to be the major data deficiency in the assessment and the need of such survey to be established is growing.

6.4.8.1 Short term considerations

State of the spawning stock size:
The assessment is considered only indicative of relative stock trends. All three assessment formulations indicate that the SSB in 2012 is increasing from previous year. In the absence of total stock size estimates and biological reference points, EWG 13-12 is unable to fully evaluate the stock size with regard to the precautionary approach.

State of recruitment:
Recruitment is indicated to have varied without a clear trend since 2004.

State of exploitation:
Given the current state of the assessment of horse mackerel in the Black Sea, EWG 13-12 is unable to provide a biological reference point consistent with high long term yield nor to quantify the expoitation rate. Based on the assessment results the exploitation rate appears to have varied since 2004 without a clear trend. In the absence of a biological reference points, EWG 13-12 is unable to fully evaluate the exploitation state with regard to the precautionary approach.

6.4.8.2 Medium term considerations

Given the current state of the assessment of horse mackerel in the Black Sea, EWG 13-12 is unable to provide advice for the medium term future.

6.5 Anchovy in the Black Sea

6.5.1 *Biological features*

6.5.1.1 Stock Identification

The anchovy, *Engraulis encrasicolus* is distributed all over the Black Sea (Fig. 6.5.1.1.1) and represented by at least two different stocks in the Black Sea: the Black Sea and the Azov Sea stocks (Ivanov and Beverton 1985). The later reproduces and feeds in the Azov Sea and hibernates along the northern Caucasian and Crimean coast of the Black Sea. In addition to these two distinct stocks, there are strong evidences for the existence of a resident stock, spawning within the Turkish EEZ and overwintering on the Anatolian coast. An alternative view to existence of more than two stocks is displacement in the spawning areas (Niermann et al. 1994). The degradation of ecological status of the spawning area was believed to lead anchovy to replace its spawning areas (Fig. 6.5.1.1.2).

The common belief is that the Black Sea anchovy migrates to the wintering grounds along the Anatolian and Caucasian coasts in southern Black Sea in October-November. In these areas they form dense hibernating concentrations until March. During this period they are subjected to intensive fishery. In the rest of the year they occupy spawning and feeding habitats across the sea with some preference to the shelf areas characterized by high productivity (Faschuk *et al*. 1995, Daskalov, 1999).

On the other hand in the view of new findings, to what extent the different forms of anchovies are discriminated in the landings and as to whether they subjected to the same nutritious conditions for growth and reproduction and to the same level of natural and fisheries mortality, are matter of assessment concerns. It is crucial to address unit stock question for anchovy in the Black Sea. Here in this assessment it was assumed that *i*) there are only two stocks of anchovy in the Black Sea; ii) the Azov Sea anchovy inhabits a rather small region confined to Sea of Azov, east of Kerch, Caucasian coast and to an extent Georgia; iii) this stock is almost exclusively fished and hence regulated by Ukraine and Russian Federation. Therefore the assessment is populated with the data pertaining only to the Black Sea anchovy.

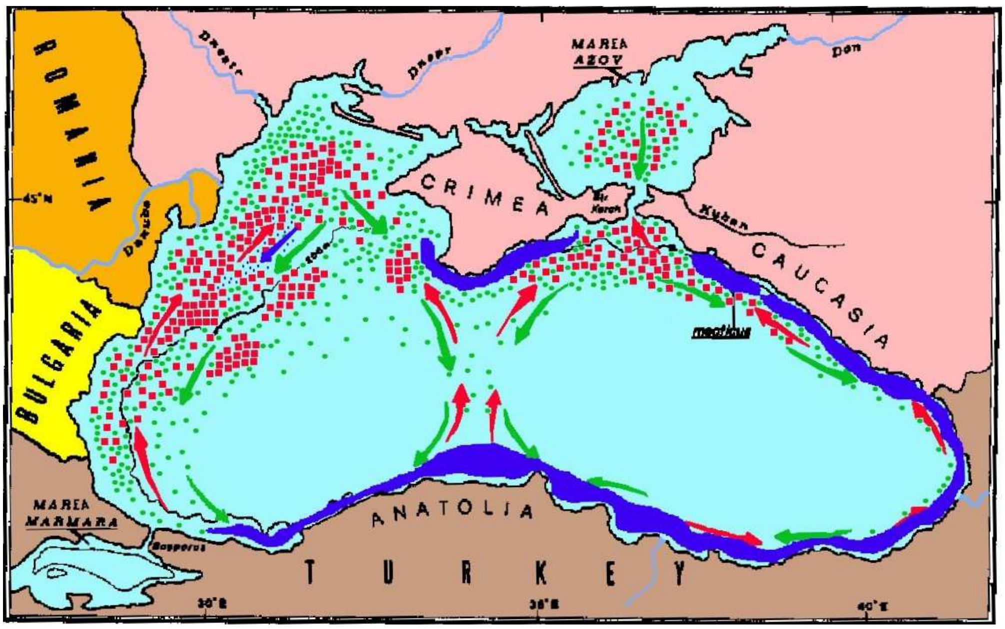


Figure 6.5.1.1.1. Distribution of the anchovy at the Romanian littoral and in the whole Black Sea.

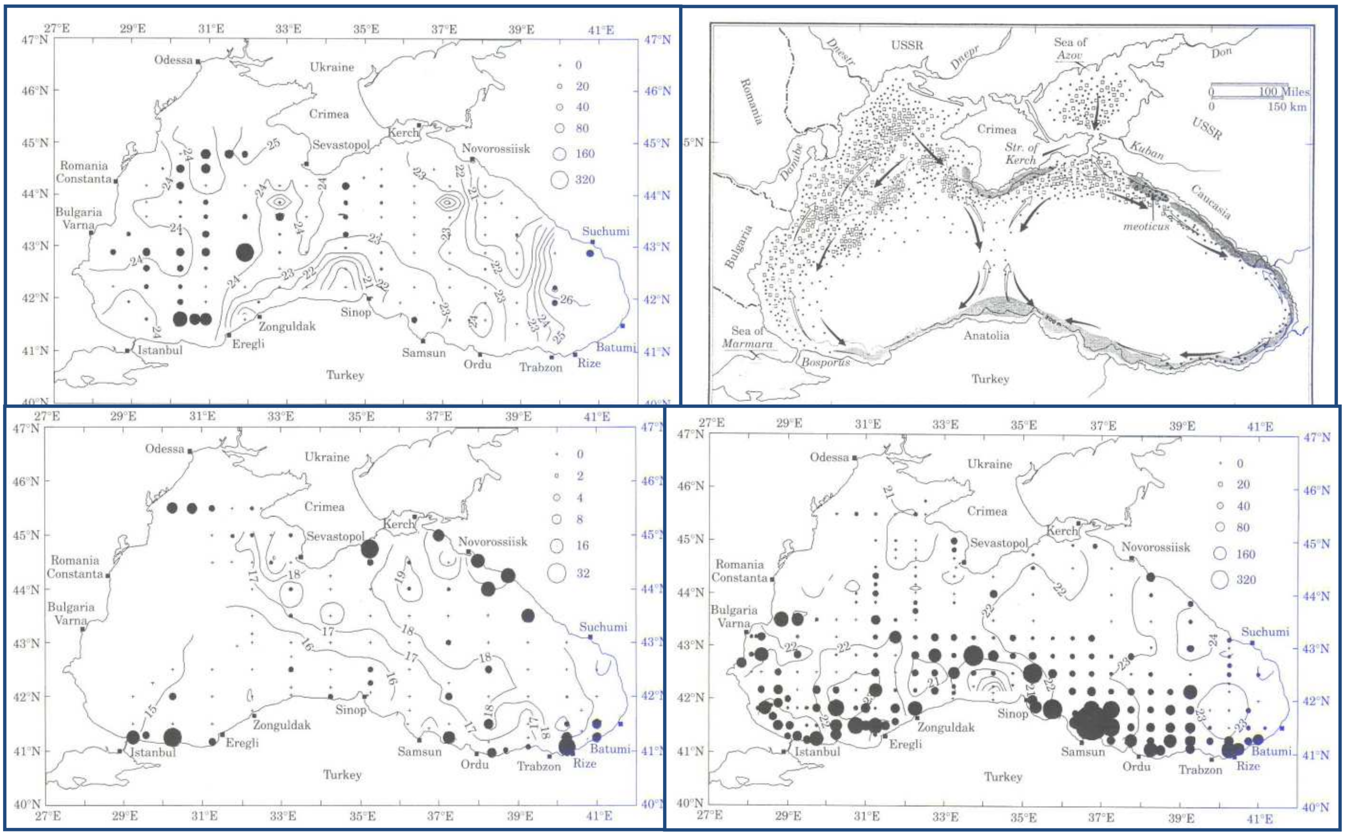


Figure 6.5.12. Egg distribution of anchovy in 1950s (upper left; Einarson and Gürtürk 1960); in 1970s (upper right, Ivanov and Beverton, 1985), and in 1990s (lower, Niermann et al. 1994).

6.5.1.2 Growth

Anchovy is a short lived species. During the last 30 year, the catch has been represented only individuals of 0 to 4 years age: The older ages (4 and older) have never been observed in the overwintering areas. The two anchovy forms (Azov and Black Sea) grow different; former growing slower (Chashchin,1996). Therefore it may worth noting that a growth estimate disregarding stock discrimination would produce results with great variance. The growth estimates reported in the literature are based on mean length of age classes. There are significant differences in mean lengths of the age classes provided by the countries. Figure 6.5.1.2.1. displays the length frequency distributions of Bulgaria, Romania and Turkey. The smallest anchovies were observed in Romanian catch while the largest are in the Bulgarian waters. The overall size range is between 4 and 14.5 cm.

In this assessment, the differences were assumed to occur due to differences in the time sampling; ie. Bulgarian catch represents the summer months when the fishes are about the complete a year cycle; Romanian data displays the size of the anchovies at the time of recruitment; the Turkish data represents the length frequency distribution of anchovies during winter.

Another important point in the anchovy growth is the seasonality. The growth which is very fast during summer, almost ceases during winter. Almost every winter a significant drop in the somatic condition of the overwintering anchovy is reported (Gucu, 2002).

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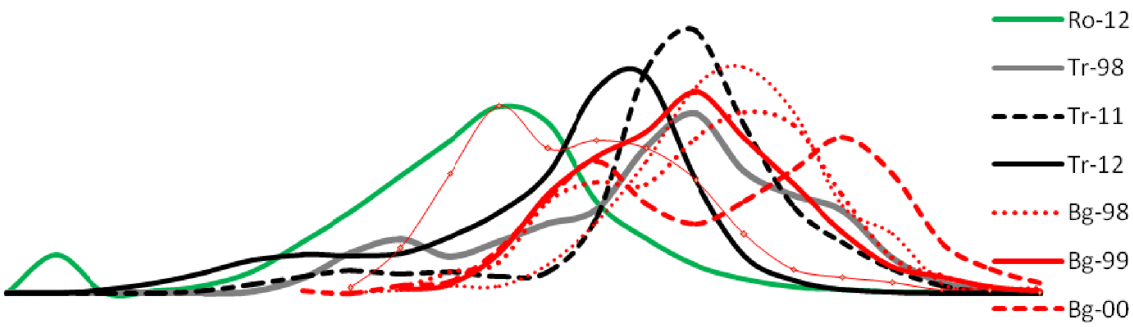


Figure 6.5.1.2.1. Length-frequency distributions reported by countries

Table 6.5.1.2.1.Some examples to the VBGF parameters estimated for Black Sea anchovy

L_∞	K	ϕ'	L_{max}	L_{mean}	Ref
16.77	0.324	1.960	16.1	12.4	Erkoyuncu & Ozdamar, 1989
16.85	0.324	1.964	16.9	10.8	Karacam & Düzgünes, 1990
14.14	0.920	2.265	-	-	Duzgunes & Karacam, 1989
17.99	0.294	1.979	15.3	9.8	Ozdamar et al., 1994
15.65	0.282	1.840	13.5	10.6	Ozdamar et al., 1994
15.73	0.317	1.895	13.0	-	Unsal, 1989
16.83	0.310	1.944	15.3	9.0	Ozdamar et al., 1995
16.84	0.233	1.820	-	10.7	Samsun et al., 2006
18.46	0.217	1.869	-	11.3	Samsun et al., 2006
18.73	0.156	1.738	-	10.2	Samsun et al., 2006
13.69	1.249	2.369	14.4	11.8	Bilgin et al., 2012
13.93	0.994	2.285	14.6	11.8	Bilgin et al., 2012

6.5.1.3 *Natural Mortality*

Table 6.5.1.3.1. Natural mortality estimates provided by the countries

Source	Age						Country
	overall	0	1	2	3	4	
1	0.85	-	-	-	-	-	Bulgaria
2	0.82	-	-	-	-	-	Ukraine
3	0.70	-	-	-	-	-	Romania
4		1.56	1.16	0.93	0.86	-	Turkey
5		1.32	0.81	0.56	0.48	0.48	overall

1) Daskalov et al., 2012; 2) Shlyakhov et al., 1990; 3) Pauly's 4) Gislason et al's; 5) STECF 2012

6.5.1.4 *Maturity*

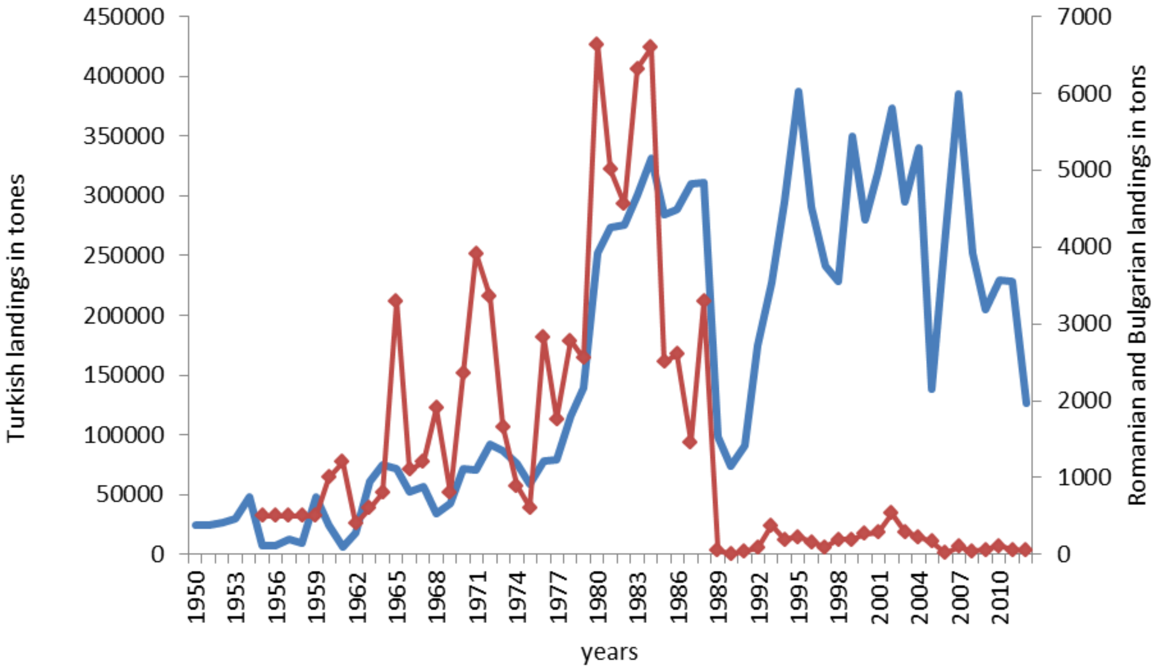
First maturity age is year 1 for anchovy. It spawns during the summer, the middle of May to the second half of August with a peak from mid-June to the end of July. This period is also the main feeding and growth season. The main feature characterizing the summer habitat is the strong stratification of the water due to the seasonal thermocline and reinforced in coastal and shelf waters by the river plumes. Anchovy was found to spawn mainly in the surface layer of these warm and stratified areas (Arkhipov, 1993; Fashchuk et al. 1995). Eggs and larvae are retained in the coastal layer stabilized in depth by the thermocline and protected from the offshore by thermo-haline fronts. A large convergence zone is formed on the northwestern and the western shelf (the main anchovy spawning area) due to the river Danube inflow, which favors fish offspring retention (Radu and Maximov 2006-2008).

Lisovenko and Andrianov (1996) estimated that a mature anchovy may produce 50 batches and the average number of eggs spawned by one female varies between 138 000 and 231 000 displaying a clear seasonal indeterminate pattern. Interestingly the same authors observed that a small part of each new generation of anchovy reach sexual maturity and spawn two-three months after hatching, at the end of the spawning season. The part of the spawning 0 year class in the population may be as high as 1.5%.

6.5.2 Fisheries

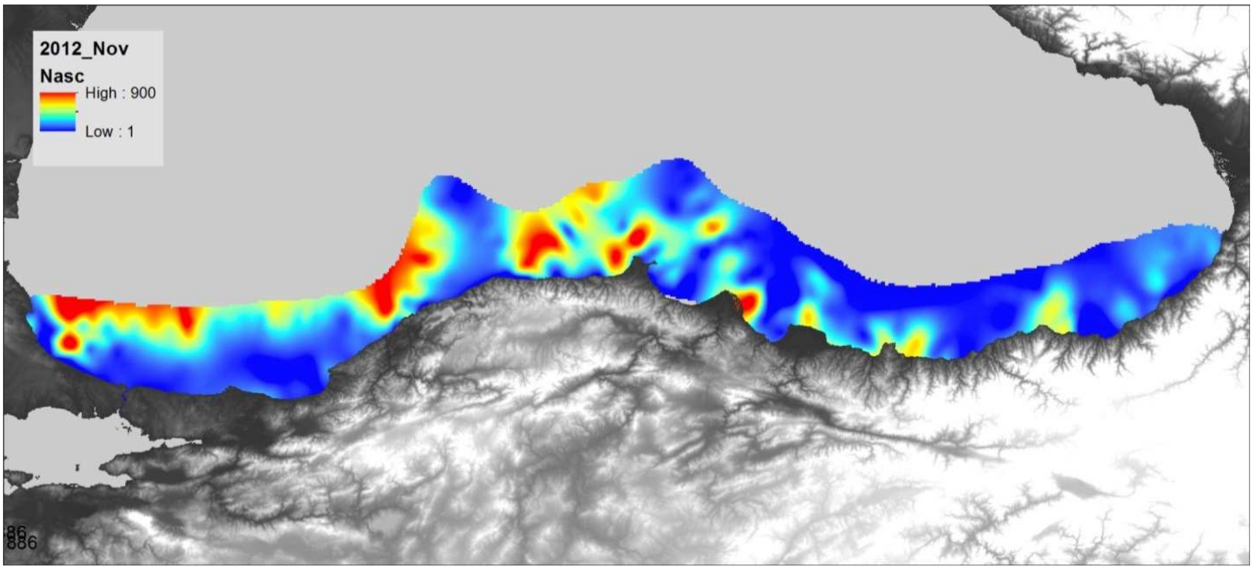
6.5.2.1 *General description*

The summer distribution area of the Black Sea anchovy covers entire Black Sea. However due to disperse spawning distribution the Black Sea stock is not the target of fishery during summer. The winter cooling in the northwest shelf area where the main spawning aggregations were used to found, forces the anchovy migrate south. According to the historical literature (Pusanov (1936) the migration route usually followed the coastlines of Romania, Bulgaria and Turkey. Old records also states that the migrating Black Sea anchovy diverts on the Turkish coast a part entered the Sea of Marmara through the Istanbul strait (Deveciyan, 1915). During the winter migration anchovy used to caught by coastal trap nets and beach seines mainly in Bulgaria, Romania however historically it was caught by coast traps along the Istanbul strait too. The main Black Sea anchovy fishery however has been carried out by purse seiners and the fleet targeted the schools over the overwintering ground located on the Turkish and Georgian waters for more than 50 years. During the years between 1960 and 1990 the anchovy catch of the countries located on the migration route has increased gradually and reach to a maxima in the first half of 1980s (**Error! Reference source not found.**.1). Almost synchronously, the anchovy catch of all Black Sea countries dropped in the second half of the 1980s. The roots of the collapse has been evaluated by various authors and fishing pressure; distrophication by Danube River and degradation of the ecosystem on the main feeding and spawning ground; destruction at the lower trophic levels of the Black Sea ecosystem by the intrusion of an alien gelatinous species were some of the factors blamed. Following the three years after the collapse, the Black Sea anchovy stock seemed to recover as can be seen from the increase in the Turkish landing (**Error! Reference source not found.**.1). However, the catch of the countries on the migration route of the species has never been increased and even reduced. This may be an indication of habitat shift and or change in the migration route.



Error! Reference source not found..1.The total landings of Romanian and Bulgaria.

Anchovy is an object of both artisanal (with and Ukraine), and commercial purse-seines estsbothsubspecies of anchovy -the Black Seaand Azov Seaanchovy. Theirregulationandregistrationof nationalstatistics of Ukraine, as well as Russian Federation, are madeseparately.

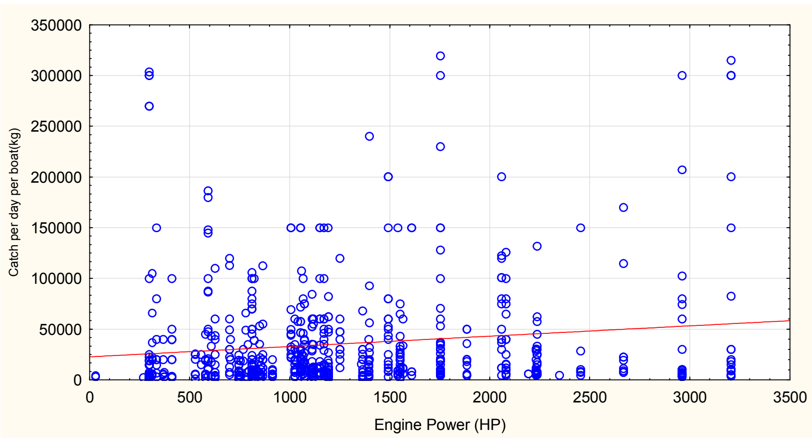


6.5.2.2 *Management regulations applicable in 2012 and 2013*

In the Black Sea countries, anchovy fishing are generally regulated by i) closed seasons (May April to October/November for Bulgaria and Romania, April to September for Turkey, and no closed season for Ukraine), ii) closed areas, iii) mesh size regulations, iv) minimum landing size (9 cm total length in general and 7 cm TL for Georgia). The Black Sea and Azov anchovy are treated as two different stocks in Ukraine and in the Russian Federation and the fishery is managed separately for each stock.

Turkey as the owner of the main fleet fishing the Black Sea anchovy enforced additional measured to control the size of the fishing fleet. The fishing capacity of the fleet had been develop over the years and finally over-capitalized beyond the profitability within the last 3 decades. The issue and its consequences on the fish stocks have been recognized in mid-1990s when a significant reduction in the stocks hit the fishery sector. However a comprehensive measure has been enforced only at the beginning of 2000's. As the first step, licensing new fishing boats has been stopped in 2002 with the aim of reducing the fishing pressure on the stocks and to maintain sustainable fisheries. Despite interruptions during 2004 and 2005, the applied policy had positive effects on control of increasing fleet capacity. Since then, new entries to the fleet are only allowed when a vessel of same size is exiting from the fleet. In such cases a maximum of 20% increase in length is tolerated. Similarly in case of modification and modernization of vessels, a maximum of 20% increase in size is allowed. On the contrary, over-development of the fleet has been unintentionally encouraged through the exempt of Special Consumption Tax on the fuel used in the fishing boats. The quantity of tax-free fuel provided to a vessel is determined based on engine power of a vessel. When combined with unregulated engine power modification liberty, the subvention, in practice, implied that the larger the engine power of a vessel the more tax free fuel it would get. Consequently, although the number of fishing vessels remained unchanged over the years the total engine power and the fuel consumed by the fleet has increased remarkably. When this is associated with the reduction in the stock sizes, the fuel consumed (and the carbon emitted) to catch the same amount of had been doubled within the last decade.

The question as to whether the increased engine power of the fishing boats increases the fishing capacity of the fleet may be a matter of concern; however comparison of daily catch of the boats with respect to their total engine power shows no significant relation (Figure 6.5.2.1.1). This is probably due to dense school forming behaviour of the species on the overwintering grounds. In summary the size of the main anchovy fishing fleet in the Black Sea is stable since 2005.



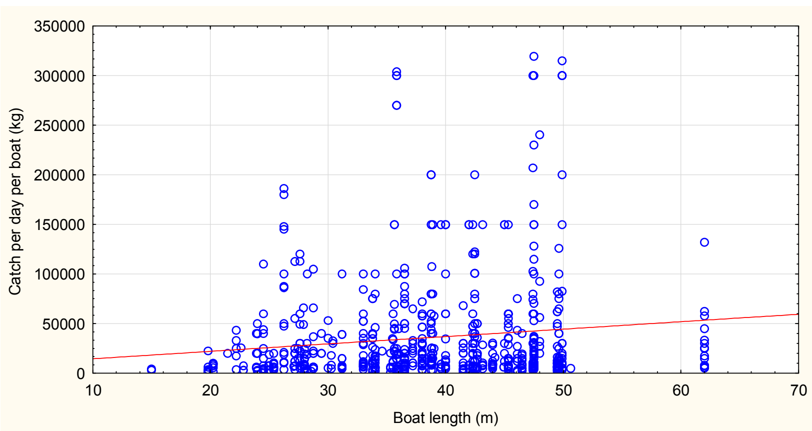


Figure 6.5.2.1.1 Testing the effects of size (lower) and engine power (upper) of an anchovy boat on the daily catch (no significant relation was found at p=0.05)

Another very substantial and promising remedy is the fishing boat buyback program launched in 2012. Given that by far greater part of the catch is landed by the industrial boats, the first phase of the program targets fishing vessels larger than 12 meters in 2012. Although the ultimate goal is to reach greater percentages in time, with the available funds allocated for the buyback program only 407 boats (156 boats of them were registered to the port on the Black Sea coast) has been removed from the fleet at this first phase in 2013. The second call for 2014 buyback program has been announced recently.

To enhance accuracy of the anchovy landing statistics, the transportation of anchovy from the landing site to the market were permitted through "transport forms" filled for each vessel and issued by the local fisheries authorities or fishing cooperatives. The regulation was first enforced on 21.08.2008 ony for anchovy, and expanded to all species landed in a quantity larger than 50 kg on 18.08.2012.

As of 18.08.2012 the minimum depth limit allowed for purse seine and for pelagic trawls has been increased from 18 to 24 meters. Considering that the anchovy overwintering on the Anatolian coast are confined to 0 to 100 meters, the regulation has noticeable positive effect on the reduction of fishing pressure on the anchovy stocks.

6.5.2.3 Catches

6.5.2.3.1*Landings*

The anchovy landings during the period 1994 – 2011 by countries are presented on Table. 6.5.2.3.1.1. The data presented under Ukrainebelongexclusivelyto the Black Seaanchovy (Azov anchovy excluded). In1997-2006,the Ukrainian fleetfishedthe Black Seaanchovy, not only in their own waters, but also in waters of Georgia. Georgia was not represented by a national expert, therefore the actual catch of the country is not known. However, made available to the report by national ; however it is known that the quota allocated for anchovy fishery has been filled in 2012-2013 fishing season. Therefore the quota figure (60 000 tons) was used as the total landing of this country in the following table. It was also assumed that Russian Federations targets only Azov anchovy and the Black Sea anchovy catch of this country is negligibly low.

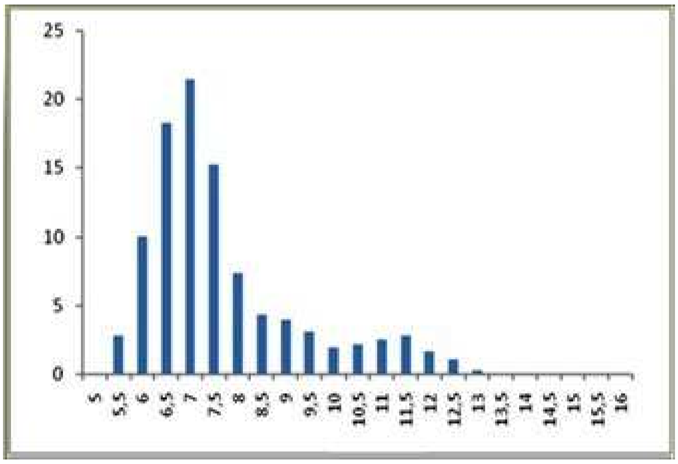
Table 6.5.2.3.1.1 Black Sea anchovy landings (t) by countries.

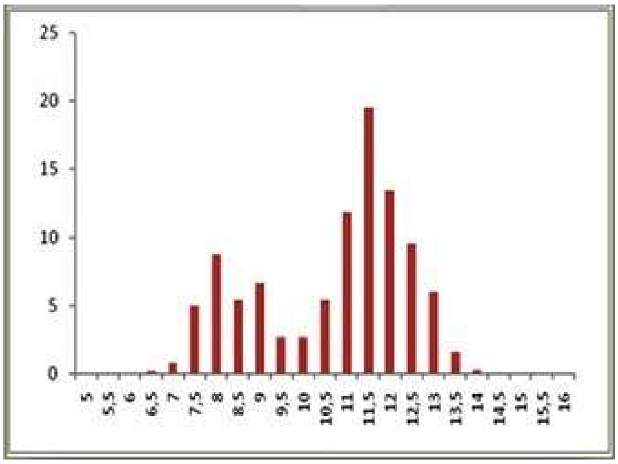
Year	Bulgaria	Georgia	Romania	Turkey	Ukraine	USSR
1967				55517		
1968				33135		
1969				40787		
1970	90			67109		117800
1971	126			65353		126700
1972	156			85906		111000
1973	264			84216		132500
1974	41			70802		227900
1975	15			58216		173626
1976	72			67992		236234
1977	113			71366		152607
1978	37			105183		134855
1979	307			133678		126763
1980	209			239289		165900

1981	70			259767		153272
1982	266			266523		175100
1983	784			289860		200630
1984	239			318917		240640
1985	92			273274		110200
1986	96			274740		191370
1987	13			295902		66241
1988	115	97452		295000		
1989		32401		96806		
1990		4656		66409		
1991		5643		79225		
1992		6871		155417	2572	
1993		1656		218866	1598	
1994		857	197	278667	242	
1995	35	1301	190	373782	888	
1996	23	1232	140	273239	596	
1997	44	2288	45	213780	3623	
1998	48	2346	146	195996	1039	
1999	36	1264	155	310801	4872	
2000	64	1487	204	260670	7719	
2001	102	941	186	288616	5915	
2002	237	927	296	336419	6739	
2003	131	2665	160	266069	8868	
2004	88	2562	135	306656	5687	
2005	14	2600	154	119255	6200	
2006	6	9222	23	212081	4907	
2007	60	17447	87	357089	3363	
2008	28	25938	15	225344	3761	
2009	42		21	185606	4653	
2010	65	39857	50	203026	5051	
2011	18	25919	41	205243	6932	
2012	7.4	60000	18	126331	6823	

6.5.2.3.2*Discards*

In general the selectivity of a purse seine used to catch small pelagics is considered negligible and it is assumed that all small pelagic fish caught by the purse seine fishery are landed. In the last 10 years, the great demand of fish meal and oil factories led the fishers target all fish schools detected on the sonars, including those under the minimum allowable size limits. For a better enforcement of the minimum size regulation, the controls at the landing sites and in the factories have been increased by the Turkish authorities. However due to schooling behavior of the anchovy during winter it is not practically possible to discriminate undersized fishes from the larger sized anchovies during the purse seining operation. Therefore in an attempt get rid of undersized fished before landing use of "fish grader" became very common. With this device legal sized fishes are retained and the rest are simply discarded at sea. In some cases, when the catch in an operation is composed of greater percentage of undersized anchovies, the operation is aborted and the fish in the net is released. However the survival of fish after such an operation is almost zero and it is quite common to find huge amount of decaying fish bulks lying on the bottom in the areas where the purse seining is concentrated. Very critical consequences of this unreported anchovy catch is underrepresentation of zero year class in the landings. **Error! Reference source not found.**. is the comparison of length distribution of landed anchovies and those sampled by a fine meshed (14 mm stretched) pelagic trawl in the same region and at the same time. Moreover the percentage of anchovy catch discarded by this way increased remarkably in 2013. The estimated discard rate in number of fish is 4% in 2011 and 14% in 2012





Error! Reference source not found..Length frequency distribution of anchovies sampled at sea by fine-med pelagic trawl (left) and at the landing sites (right)

6.5.2.4 Fishing effort

No data concerning the fishing effort for anchovy were made available for the report for most of the countries; therefore it was not possible to estimate the overall fishing effort for the anchovy fishery in the Black Sea. The only exception is Turkish fleet where both HP (kW) and GT's are available. On the other hand, no correlation was found between engine power or length of anchovy boat and its daily catch. Therefore it was assumed that the number of boats registered for anchovy fishery would sufficiently reflect the fishing effort of the fleet.

Number of boats in the Turkish fleet engaged in anchovy fishery is available since 1950s; however as Turkey is not the only country fishing the anchovy in the Black Sea it would not be realistic to use Turkish data only as an index of the overall fishing effort in the Black Sea. Nevertheless following the anchovy collapse in late 1980s Turkey became the main exploiter of the Black Sea anchovy. Almost 95% of the stock has been fished by the Turkish fishermen. Moreover, by a bilateral agreement between two countries the anchovies in Georgian waters are exploited by the Turkish fishing boats. Therefore it is assumed that, the data presented in Table 6.5.2.4.1, to a reasonable extent, represents the entire Black Sea.

Table 6.5.2.1.1. Number of vessels in the Turkish fishing fleet engaged in anchovy fishery

Year	# of vessels		Year	# of vessels
1988	94		2001	299
1989	126		2002	419
1990	125		2003	473
1991	131		2004	388
1992	163		2005	497
1993	287		2006	428
1994	243		2007	473

1995	262		2008	566
1996	278		2009	483
1997	248		2010	409
1998	209		2011	384
1999	199		2012	339
2000	262			

6.5.2.5 Commercial CPUE

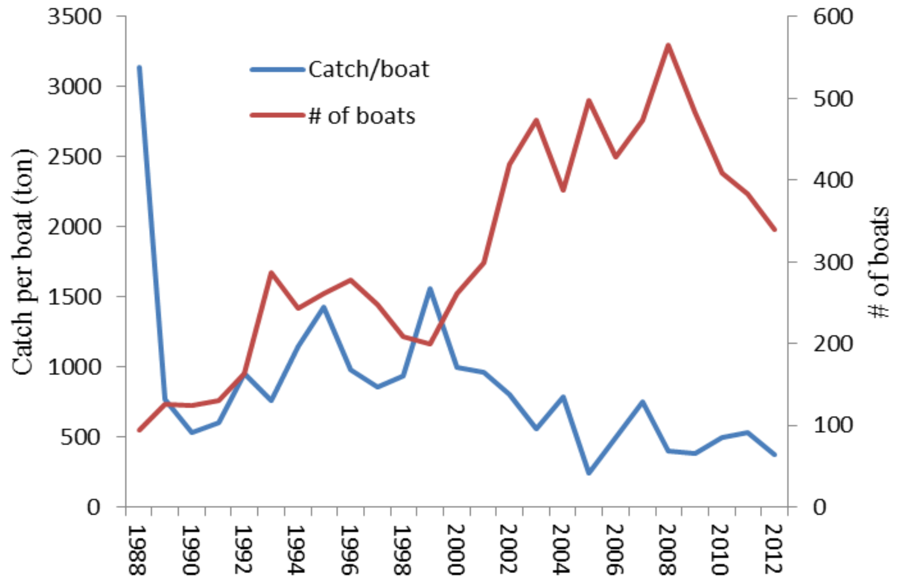


Figure6.5.2.2.1. CPUE trends.

Table 6.5.2.3.1. CPUE by age groups

Year/Age	0 year	I year	II year	III year	IV year
1988	8769	60775.37842	54136.04044	2344.65009	-
1989	62712	19924.22488	963.2427295	309.1843728	-
1990	59580	4439.756984	1440.18285	448.7431069	-
1991	37027	15928.46412	3010.220707	159.3734734	-
1992	82562	74112.07613	7222.866805	162.0033446	-
1993	67040	54297.94869	9163.64688	514.4846871	-
1994	79179	64129.67602	10822.90804	607.6424082	-
1995	160617	60683.44493	11222.62974	93.36135901	-
1996	28405.15081	47075.39548	36374.22643	3954.208057	-
1997	23543.29982	54548.51589	24820.71931	3097.482686	-
1998	25805.90103	59639.21924	27078.46149	3376.631585	0.530139407
1999	44281.97851	101243.0835	45071.10823	5615.269732	0.340946909
2000	27948.19595	66328.36787	29032.21748	3617.789926	0.873456015
2001	5509.563069	40909.78909	39613.7641	7735.399015	-
2002	4297.910651	34606.39763	33001.35912	6444.998937	-
2003	3327.283721	24858.3207	23194.46261	4515.851331	-
2004	21073.94017	42703.56657	23441.25768	1866.721974	-
2005	12138.88016	7378.145925	9251.573753	654.2102651	-
2006	34016.68727	27210.56845	11328.17395	380.4988169	-

2007	85149.85948	72024.18422	27412.46566	812.7337495	-
2008	21783.25698	32495.71022	22712.56859	843.2386863	-
2009	31831.2226	29600.9084	16102.51345	618.8930503	-
2010	26859.94386	36775.39668	36307.12981	1571.504803	-
2011	36037.56241	53057.89758	23774.76111	1274.64677	259.6966374
2012	105250.5955	48226.85303	9699.096358	966.248896	660.9698195

6.5.3 Scientific Surveys

6.5.3.1 *Hydroacoustic surveys*

No scientific survey on anchovy was reported by the countries, except Turkey. The Turkish Ministry of Food, Agriculture and Livestock has launched a fisheries project on Black Sea anchovy. The project initially aimed to conduct acoustic surveys on the Turkish continental shelf during the overwintering season of the species. Until now four surveys were carried out in 2011 (November-December) and 2012 (January-February; November, December; Figure 6.5.3.1.1. In each survey, complementary pelagic trawl sampling was also performed to determine size/age distribution of anchovies. The net used in the pelagic trawl sampling designed to catch both fast swimming adults and small sized recruits at the same time. It has very fine mesh size (14 mm stretched) and equipped with a pair of SIMRAD trawl sensors attached to head rope and bottom line.

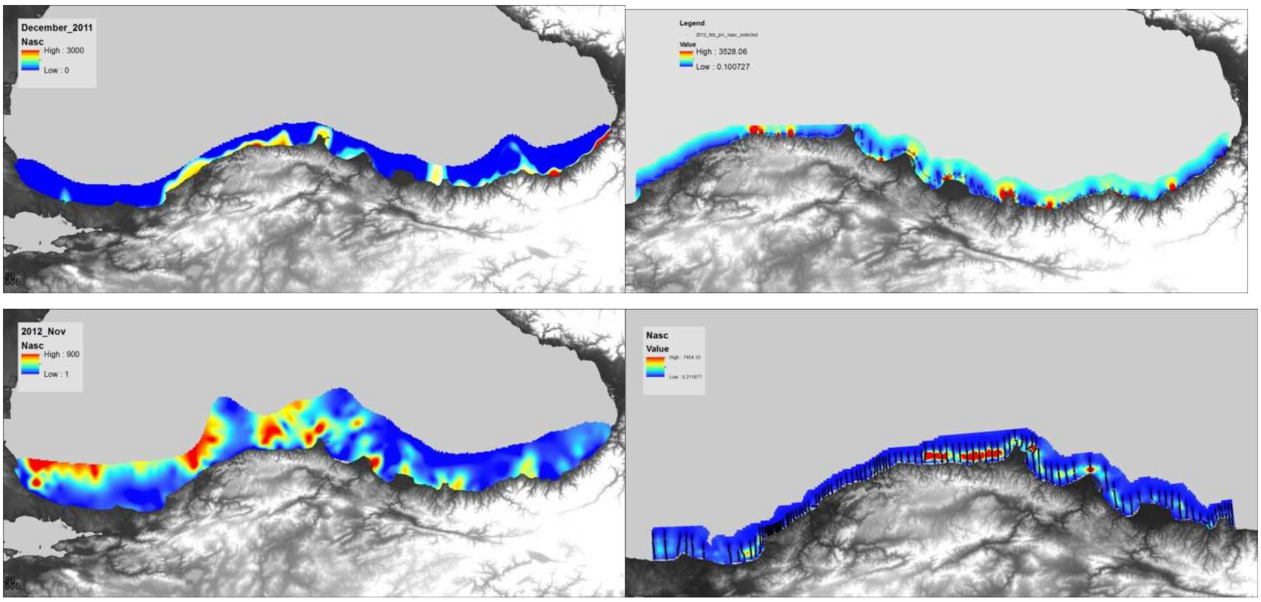


Figure 6.5.3.1.1. Distribution maps of anchovies in November-December 2011 (upper left); January-February 2012 (upper right); November 2012 (lower left) and December 2012 (lower right)

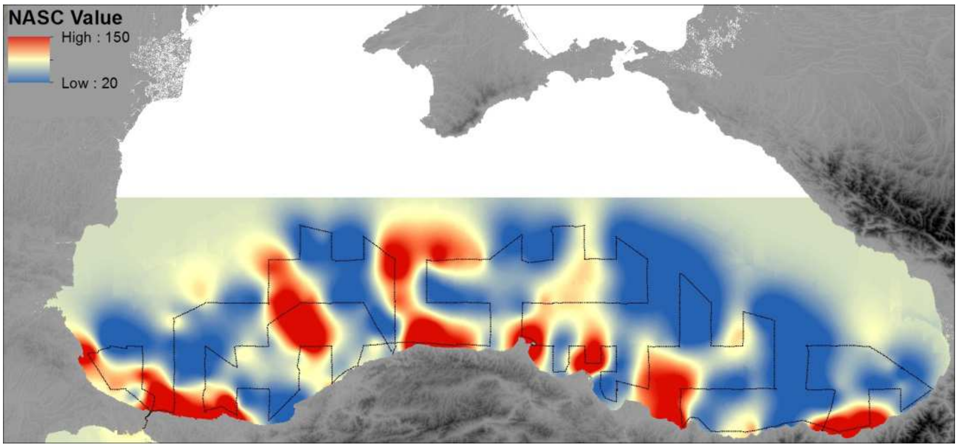


Figure 6.5.3.1.2. Distribution of spawning stock acoustically detected in July 2013

6.5.3.2 Egg and Larvae Surveys

In 2013, in an attempt to estimate spawning stock within the southern Black Sea an additional survey covering the entire extent of the Turkish EEZ was carried out during anchovy spawning season (). In addition to hydroacoustics, egg and larvae were also sampled at the stations presented in Figure 6.5.3..

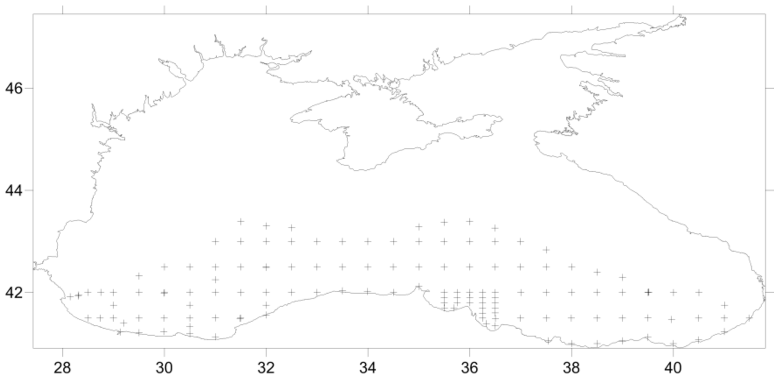


Figure 6.5.3.2.1. Ichtyoplankton survey carried out in July 2013

6.5.3.3 Landing site surveys

The Central Fisheries Research Institute based in Trabzon Turkey monitors the biological parameters of the anchovy landed on the eastern coast of the Turkey. The study was initiated in 1980s and continued until 1998. After 6-7 years of interruption, the monitoring program has been initiated again and continued since then. The main parameters measured are monthly length/weight frequency distributions of the landed anchovies, ALKs, and somatic condition of the species.

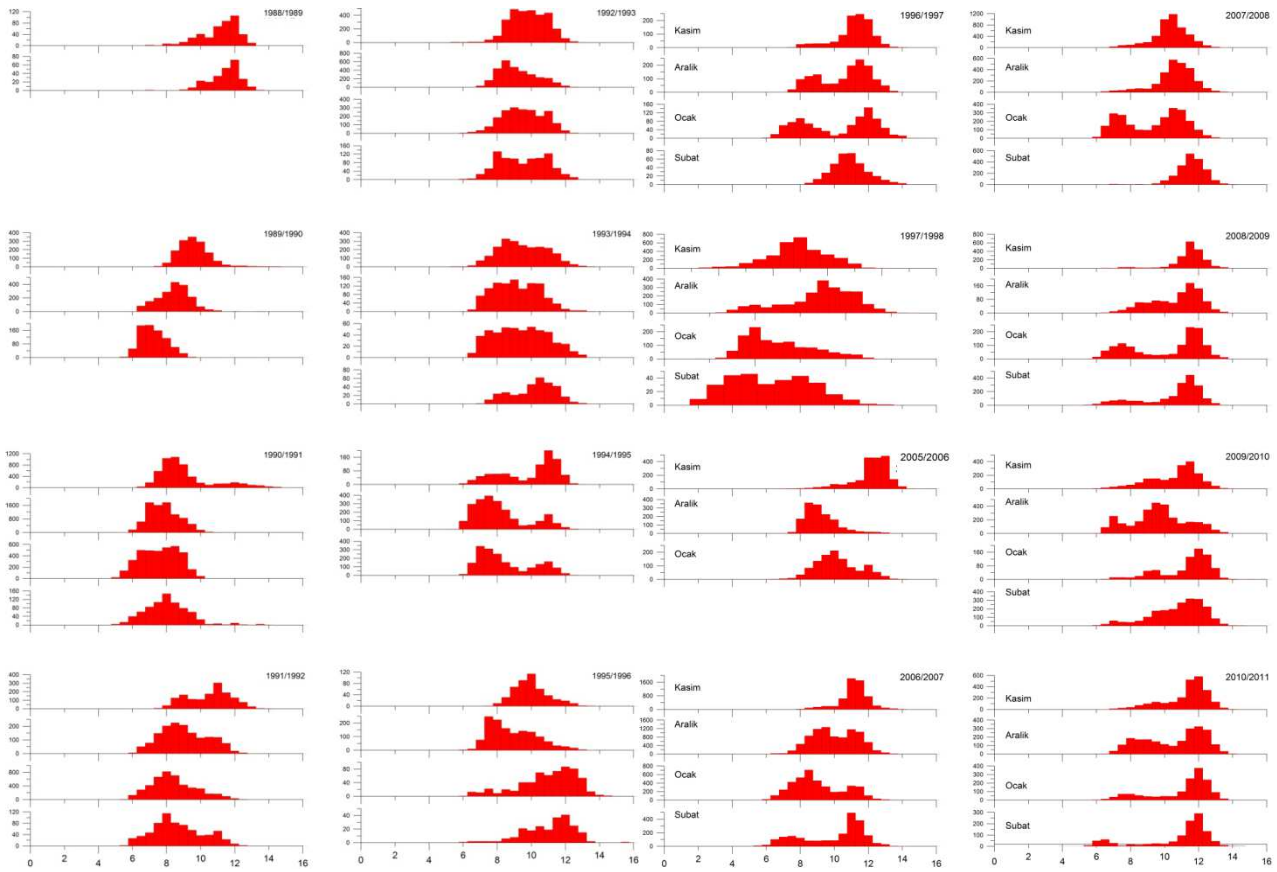


Figure 6.5.3.3.1. Time series of the length frequency distributions of the Black Sea anchovy sampled at the Turkish landing sites by SUMAE.

6.5.4 *Assessment of historic parameters*

6.5.4.1 *Method 1: XSA*

6.5.4.1.1*Jusification*

For the sake of consistency, theanchovy stock was first assessed quantitatively by XSA. The model was tuned with the CPUE at age derived from the Turkish commercial purse seiner fishery as this fleet holds a share of about 95% of the total Black Sea anchovy landing.

6.5.4.1.2*Input parameters*

The data used for assessment and their availability by year and by country is presented in the following table.

Table 6.5.4.1.2.1. Imput parameters.

Type of data	BG	GE	RO	UKR	TR	Comments
Official landings	1970-2012	1988-2011	1994-2012	1967 - 2012	1967 - 2012	
Discard	Na	Na	2012	na	2011-2012	
Illegal. Unreported Catch	Na	Na	Na	na	Na	
Fishing effort and CPUE	Na	Na	Na	na	1988-2012	
Number of fishing vessels	Na	Na	Na		1988-2012	

Research surveys -adult	Na	Na	Na	till 2005	2011-2013	
Reserch surveys -juvenile	Na	Na	Na	till 1992	na	
Hydroacoustic surveys	Na	Na	Na	1992. 1998-2003	1990-1993	
Length composition	1998-2000	2011-2012*	1980-2008	till 2008	1988-2012	* via Turkish boats
Weight at length (survey. landings)	1998-2000. *VII. VIII. IX. XI.1999	Na	1980-2008	till 2006	1988-1997 2004-2012	
Age composition	1995-2000. VII. VIII. IX. XI.1999	Na	1980-2008	till 2005	1988-1997 2004-2012	
Weight at age (survey. landings)	1995-2000	Na	1980-2008	till 2005	1988-1997 2004-2012	
Maturity at age	Na	Na	1980-2008		NA	
Natural mortality	Na	Na	1980-2008	till 1990	NA	

Table 6.5.4.1.2.2 XSA input data.

An object of class "FLStock"
Slot "catch":
An object of class "FLQuant", , unit = unique, season = all, area = unique

year													
age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
all	261342	90303	62757	71584	137296	196120	250273	338178	261347	210546	248747	358424	243227

year												
age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
all	316811	332005	284815	279949	115976	203932	321089	226068	175361	239856	232446	228986

Slot "catch.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year										
age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	2165842	16430588	16682296	10515780	13457543	19240499	42079752	25590787	16213594	5838738
1	15011518	5220147	1243132	4523684	12080268	15583511	15897946	21918772	15724393	13528032
2	13371602	252370	403251	854903	1177327	2629967	2939827	8556294	6964770	6155538
3	579129	81006	125648	45262	26407	147657	24386	1236664	947668	768176

year										
age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	5393433	8812114	7322427	1647360	1800825	1573805	8113535	6033023	14559142	23494265
1	12464597	20147374	17378033	12232027	14500081	11757985	16438121	3666938	11646123	19872673
2	5659399	8969151	7606441	11844515	13827570	10970980	9020434	4598032	4848459	7563556
3	705716	1117438	947861	2312884	2700455	2135997	718386	325143	162853	224247
4		111	68	229						

year					
age	2008	2009	2010	2011	2012
0	8219549	10249653	7323812	9225602	23786624
1	12261714	9531493	10027425	13582799	10899264
2	8570209	5185010	9899744	6086328	2191995
3	318182	199283	428497	326309	218372
4				66482	149377

units: NA

Slot "catch.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year									
age	1988	1989	1990	1991	1992	1993	1994	1995	1996

```
 0      0.0032735  0.0032735  0.0028380  0.0029510  0.0031332  0.0030036  0.0026658  0.0032043  0.0034900
 1      0.0062166  0.0062166  0.0065551  0.0068004  0.0068295  0.0069072  0.0067623  0.0066000  0.0071900
 2      0.0113996  0.0113996  0.0131032  0.0106727  0.0104065  0.0108562  0.0102922  0.0109401  0.0112400
 3      0.0146798  0.0146798  0.0157664  0.0146850  0.0142668  0.0144884  0.0136375  0.0144812  0.0141600
 4      0.0000000  0.0000000  0.0000000  0.0000000  0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
   year
age     1997       1998       1999       2000       2001       2002       2003       2004       2005
 0      0.0037800  0.0046000  0.0040000  0.0020000  0.0051000  0.0043000  0.0058000  0.0046000  0.0044000
 1      0.0078800  0.0108000  0.0102000  0.0067000  0.0099000  0.0079000  0.0070000  0.0087000  0.0081000
 2      0.0116100  0.0137000  0.0115000  0.0126000  0.0131000  0.0121000  0.0142000  0.0100000  0.0120000
 3      0.0135500  0.0167000  0.0130000  0.0172000  0.0139000  0.0157000  0.0176000  0.0131000  0.0140000
 4      0.0000000  0.0000000  0.0000000  0.0220000  0.0000000  0.0000000  0.0000000  0.0000000  0.0000000
   year
age     2006       2007       2008       2009       2010       2011       2012
 0      0.0039000  0.0041000  0.0032000  0.0040000  0.0038000  0.0037000  0.0045000
 1      0.0081000  0.0074000  0.0086000  0.0080000  0.0093000  0.0085000  0.0088000
 2      0.0104000  0.0099000  0.0105000  0.0107000  0.0114000  0.0127000  0.0101000
 3      0.0147000  0.0126000  0.0136000  0.0132000  0.0138000  0.0148000  0.0114000
 4      0.0000000  0.0000000  0.0000000  0.0000000  0.0000000  0.0110000  0.0094000

units:  NA

Slot "discards":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
  all 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
     year
age   2005 2006 2007 2008 2009 2010 2011 2012
  all 0    0    0    0    0    0    0    0

units:  NA

Slot "discards.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2005 2006 2007 2008 2009 2010 2011 2012
  0 0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0

units:  NA

Slot "discards.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2005 2006 2007 2008 2009 2010 2011 2012
  0 0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0
```

units: NA

Slot "landings":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year													
age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
all	392452	129207	71065	84868	162288	220522	279524	375083	274471	216068	198342	312065	262157

year												
age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
all	289557	337346	268734	309218	121855	221303	374536	251282	185606	242883	233483	197403

units: NA

Slot "landings.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year										
age	1988	1989	1990	199	1992	1993	1994	1995	1996	1997
0	2165842	16430588	16682296	10515780	13457543	19240499	42079752	25590787	16213594	5838738
1	15011518	5220147	1243132	4523684	12080268	15583511	15897946	21918772	15724393	13528032
2	13371602	252370	403251	854903	1177327	2629967	2939827	8556294	6964770	6155538
3	579129	81006	125648	45262	26407	147657	24386	1236664	947668	768176

year										
age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	5393433	8812114	7322427	1647360	1800825	1573805	8113535	6033023	14559142	23494265
1	12464597	20147374	17378033	12232027	14500081	11757985	16438121	3666938	11646123	19872673
2	5659399	8969151	7606441	11844515	13827570	10970980	9020434	4598032	4848459	7563556
3	705716	1117438	947861	2312884	2700455	2135997	718386	325143	162853	224247
4	111	68	229							

year					
age	2008	2009	2010	2011	2012
0	8219549	10249653	7323812	9225602	23786624
1	12261714	9531493	10027425	13582799	10899264
2	8570209	5185010	9899744	6086328	2191995
3	318182	199283	428497	326309	218372
4				66482	149377

units: NA

Slot "landings.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year									
age	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	0.0032735	0.0032735	0.0028380	0.0029510	0.0031332	0.0030036	0.0026658	0.0032043	0.0034900
1	0.0062166	0.0062166	0.0065551	0.0068004	0.0068295	0.0069072	0.0067623	0.0066000	0.0071900
2	0.0113996	0.0113996	0.0131032	0.0106727	0.0104065	0.0108562	0.0102922	0.0109401	0.0112400
3	0.0146798	0.0146798	0.0157664	0.0146850	0.0142668	0.0144884	0.0136375	0.0144812	0.0141600

year									
age	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.0037800	0.0046000	0.0040000	0.0020000	0.0051000	0.0043000	0.0058000	0.0046000	0.0044000
1	0.0078800	0.0108000	0.0102000	0.0067000	0.0099000	0.0079000	0.0070000	0.0087000	0.0081000
2	0.0116100	0.0137000	0.0115000	0.0126000	0.0131000	0.0121000	0.0142000	0.0100000	0.0120000
3	0.0135500	0.0167000	0.0130000	0.0172000	0.0139000	0.0157000	0.0176000	0.0131000	0.0140000
4	0.0000000	0.0000000	0.0000000	0.0220000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

year							
age	2006	2007	2008	2009	2010	2011	2012
0	0.0039000	0.0041000	0.0032000	0.0040000	0.0038000	0.0037000	0.0045000
1	0.0081000	0.0074000	0.0086000	0.0080000	0.0093000	0.0085000	0.0088000
2	0.0104000	0.0099000	0.0105000	0.0107000	0.0114000	0.0127000	0.0101000
3	0.0147000	0.0126000	0.0136000	0.0132000	0.0138000	0.0148000	0.0114000
4	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0110000	0.0094000

units: NA

Slot "stock":
An object of class "FLQuant"

```
, , unit = unique, season = all, area = unique

   year
        1988  1989  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000
           0     0     0     0     0     0     0     0     0     0     0     0     0
year
        2001  2002  2003  2004  2005  2006  2007  2008  2009  2010  2011  2012
           0     0     0     0     0     0     0     0     0     0     0     0

units:  NA * NA

Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year
age  1988       1989       1990       1991       1992       1993       1994       1995
 0   3.8874e+07 4.8881e+07 7.3667e+07 1.1891e+08 1.7378e+08 2.6333e+08 3.1912e+08 2.4763e+08
 1   2.4002e+07 9.2651e+06 4.5657e+06 1.1057e+07 2.6330e+07 3.9468e+07 6.0401e+07 6.3499e+07
 2   1.8045e+07 6.6523e+05 6.3995e+05 1.2020e+06 1.9015e+06 3.6560e+06 7.1637e+06 1.6266e+07
 3   7.4907e+05 2.0145e+05 1.8925e+05 6.0776e+04 4.0453e+04 1.9635e+05 1.0063e+05 1.8701e+06
 4   1.1301e+01 2.3950e+01 1.3927e+01 1.2033e+01 1.4206e+01 1.1860e+01 4.0279e+01 1.3993e+01
  year
age  1996       1997       1998       1999       2000       2001       2002       2003
 0   2.3610e+08 2.3056e+08 3.1806e+08 3.4851e+08 3.0985e+08 2.3390e+08 1.8079e+08 1.5253e+08
 1   5.2925e+07 5.4691e+07 5.8573e+07 8.2179e+07 8.8546e+07 7.8988e+07 6.1632e+07 4.7364e+07
 2   1.3629e+07 1.3056e+07 1.5307e+07 1.7743e+07 2.3120e+07 2.7800e+07 2.6980e+07 1.7746e+07
 3   2.8248e+06 2.5210e+06 2.8057e+06 4.4661e+06 3.3564e+06 7.4575e+06 6.9275e+06 4.9604e+06
 4   2.8884e+01 3.1883e+01 4.3048e+02 2.6514e+02 7.8917e+02 3.1311e+01 2.4736e+01 2.2300e+01
  year
age  2004       2005       2006       2007       2008       2009       2010       2011
 0   1.0075e+08 1.7362e+08 2.4402e+08 1.9299e+08 1.9606e+08 1.5686e+08 1.8241e+08 2.2274e+08
 1   3.9934e+07 2.2720e+07 4.3263e+07 5.7661e+07 3.9412e+07 4.8126e+07 3.6604e+07 4.4943e+07
 2   1.3228e+07 6.8009e+06 7.6614e+06 1.1478e+07 1.2397e+07 9.3544e+06 1.5052e+07 9.5955e+06
 3   1.8450e+06 7.3841e+05 4.0962e+05 7.1190e+05 8.4003e+05 6.0379e+05 1.4246e+06 1.1156e+06
 4   2.4765e+01 2.1785e+01 2.4235e+01 3.0816e+01 2.5483e+01 2.9373e+01 3.2308e+01 2.2104e+05
  year
age  2012
 0   2.4378e+08
 1   5.4734e+07
 2   1.0934e+07
3    8.8111e+05
 4   5.8810e+05

units:  NA

Slot "stock.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

  year
age  1988      1989      1990      1991      1992      1993      1994      1995      1996
 0   0.0032735 0.0032735 0.0028380 0.0029510 0.0031332 0.0030036 0.0026658 0.0032043 0.0034900
 1   0.0062166 0.0062166 0.0065551 0.0068004 0.0068295 0.0069072 0.0067623 0.0066000 0.0071900
 2   0.0113996 0.0113996 0.0131032 0.0106727 0.0104065 0.0108562 0.0102922 0.0109401 0.0112400
 3   0.0146798 0.0146798 0.0157664 0.0146850 0.0142668 0.0144884 0.0136375 0.0144812 0.0141600
 4   0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
  year
age  1997      1998      1999      2000      2001      2002      2003      2004      2005
 0   0.0037800 0.0046000 0.0040000 0.0020000 0.0051000 0.0043000 0.0058000 0.0046000 0.0044000
 1   0.0078800 0.0108000 0.0102000 0.0067000 0.0099000 0.0079000 0.0070000 0.0087000 0.0081000
 2   0.0116100 0.0137000 0.0115000 0.0126000 0.0131000 0.0121000 0.0142000 0.0100000 0.0120000
 3   0.0135500 0.0167000 0.0130000 0.0172000 0.0139000 0.0157000 0.0176000 0.0131000 0.0140000
 4   0.0000000 0.0000000 0.0000000 0.0220000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
  year
age  2006      2007      2008      2009      2010      2011      2012
 0   0.0039000 0.0041000 0.0032000 0.0040000 0.0038000 0.0037000 0.0045000
 1   0.0081000 0.0074000 0.0086000 0.0080000 0.0093000 0.0085000 0.0088000
 2   0.0104000 0.0099000 0.0105000 0.0107000 0.0114000 0.0127000 0.0101000
 3   0.0147000 0.0126000 0.0136000 0.0132000 0.0138000 0.0148000 0.0114000
 4   0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0110000 0.0094000

units:  NA
```

Slot "m":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32
1	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
2	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
3	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
4	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48

age \ year	2005	2006	2007	2008	2009	2010	2011	2012
0	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32
1	0.81	0.81	0.81	0.81	0.82	0.81	0.81	0.81
2	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
3	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
4	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48

units: NA

Slot "mat":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

age \ year	2007	2008	2009	2010	2011	2012
0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1

units: NA

Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0.114061	1.050813	0.576511	0.187658	0.162318	0.152413	0.294540	0.223072	0.142562	0.050238
1	2.775774	1.862619	0.524621	0.950398	1.164360	0.896456	0.501908	0.728844	0.589599	0.463399
2	3.935086	0.697080	1.794196	2.831568	1.710488	3.032686	0.783035	1.190667	1.127525	0.977623
3	4.065134	0.715779	1.858122	2.932567	1.771033	3.123032	0.368275	1.836676	0.555967	0.489983
4	4.065134	0.715779	1.858122	2.932567	1.771033	3.123032	0.368275	1.836676	0.555967	0.489983

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.033359	0.050158	0.046801	0.013720	0.019461	0.020165	0.169382	0.069596	0.122662	0.268581
1	0.384275	0.458198	0.348499	0.264203	0.435010	0.465531	0.960160	0.277048	0.516849	0.727171
2	0.671779	1.105144	0.571475	0.829521	1.133592	1.703672	2.325591	2.249579	1.816016	2.054766
3	0.385300	0.382829	0.444739	0.501317	0.684291	0.792763	0.683156	0.820459	0.704028	0.511559
4	0.385300	0.382829	0.444739	0.501317	0.684291	0.792763	0.683156	0.820459	0.704028	0.511559

age \ year	2008	2009	2010	2011	2012
0	0.084594	0.135165	0.080865	0.083530	0.209219
1	0.628220	0.352319	0.528860	0.603531	0.354619
2	2.461950	1.321979	2.042072	1.827871	0.308236
3	0.656848	0.544007	0.481884	0.464936	0.378429
4	0.656848	0.544007	0.481884	0.464936	0.378429

units: f

Slot "harvest.spwn":
An object of class "FLQuant"

```
, , unit = unique, season = all, area = unique

   year
age 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 1    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

 2    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 3    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 4    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2005 2006 2007 2008 2009 2010 2011 2012
  0    0    0    0    0    0    0    0    0
  1    0    0    0    0    0    0    0    0
  2    0    0    0    0    0    0    0    0
  3    0    0    0    0    0    0    0    0
  4    0    0    0    0    0    0    0    0

units:  NA

Slot "m.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 1    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

 2    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 3    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 4    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2005 2006 2007 2008 2009 2010 2011 2012
  0    0    0    0    0    0    0    0    0
  1    0    0    0    0    0    0    0    0
  2    0    0    0    0    0    0    0    0
  3    0    0    0    0    0    0    0    0
  4    0    0    0    0    0    0    0    0

units:  NA

Slot "range":
   min  max  plusgroup  minyear  maxyear  minfbar  maxfbar
 0    4          4       1988     2012        1        3
```

6.5.4.2 Method 2: SeparableVPA

6.5.4.2.1*Jusification*

As the XSA results were not satisfactory and due to uncertainty in the tuning the same data were assessed without tuning using separable VPA.

6.5.4.2.2*Input parameters*

The same catch at age data given above used for the sVPA model and three different terminal F value (0.8, 1.2 and 1.6.) were tested.

6.5.4.3 Method 3: ASPIC

6.5.4.3.1*Justification*

A possible problem in the failure of age dependent models could be the presentation of very few age classes in the landings. Therefore a stock production model disregarding demographic structure of the catch was also used to assess the anchovy stock.

6.5.4.3.2*Input data*

The total Black Sea anchovy landing data presented under section 6.5.2.1.1 and the Turkish anchovy fishing fleet's effort data given in section 6.5 were used in the assessment. The time range was confined to 25 years because before that year the contribution of the other countries was important accounting for 30-40% of the total landing. The input file used for ASPIC is presented in Table 6.5.4.3.4.1.

Table 6.5.4.3.5.1. ASPIC input file

```
FIT                                          ## Run type (FIT, BOT, or IRF)
"ASPIC Anchovy 1988-2012 - Total catch vs Turkish Fleet - Genaralized"
GENFIT EFT SSE 40 70 50 5.0                  ## Model type, conditioning type, objective function
112                                          ## Verbosity
500   95                                     ## Number of bootstrap trials, <= 1000
1 50000                                      ## 0=no MC search, 1=search, 2=repeated srch; N trials
1.0e-8                                       ## Convergence crit. for simplex
3.0e-8   6                                   ## Convergence crit. for restarts, N restarts
1.0e-4   12                                  ## Convergence crit. for estimating effort; N steps/yr
8.0e0                                        ## Maximum F allowed in estimating effort
0.0e0                                        ## Weighting for B1 > K as residual (usually 0 or 1)
1                                            ## Number of fisheries (data series)
1.0e0                                        ## Statistical weights for data series
0.5e0                                        ## Starting guess: B1/K
2.5e5                                        ## Starting guess: MSY
7.0e5                                        ## Starting guess: K (carrying capacity)
1.0E-3                                       ## Starting guesses: q (1 per data series)
1 1 1 1                                      ## Estimate flags (0 or 1) (B1/K, MSY, K, q1...qn)
2.0e5  6.0e5                                 ## Min and max constraints: MSY
5.0e5  1.5e7                                 ## Min and max constraints: K
4120359                                      ## Random number seed
25                                           ## Number of years of data in each series
"F  and Landings"## Data series title
CE     ## Type of data series
1988          247              392452
1989          262              129207
1990          280               71065
1991          284               84868
1992          163              162288
1993          287              220522
1994          243              279524
1995          262              375083
1996          278              274471
1997          248              216068
1998          209              198342
1999          199              312065
2000          262              262157
```

2001	299	289557
2002	419	337346
2003	473	268734
2004	388	309218
2005	497	121855
2006	428	221303
2007	276	374536
2008	377	251282
2009	322	185606
2010	273	242883
2011	256	231162.4
2012	226	186331.1

6.5.4.3.3*Diagnostics and results*

The outputs of the XSA model were displayed in Table 6.5.4.3.3.1, 6.5.4.3.3.2 and Figure 6.5.4.3.3.1. Model predicted the same pattern for recruits and a remarkable increase are displayed in the last two years. However SSB varied greatly by the selection of shrinkage value. SE_0.5 and SE_1.0 predicted a drop while SE_2.0 displayed and steady increase since2005. Similarly fishing mortality displayed an increase between 2000 and 2005 and then remained high with Se_0.5 and SE_1.0; however displayed a gradually decreasing pattern with SE_2.0.

The log residuals of three trials with different shrinkage values are presented in Figure 6.5.4.2. In general residuals are quite high as can be seen from the scale provided next to the figure. The lowest residuals were found with the highest shrinkage (SE=2). However the distribution over the age and year combinations seems rather clumped for all three cases.

Retrospective analyses of the three assessments are presented in Figure 6.5.4.3. None of the results produced a promising figure with respect to consistency of the estimates. There are severe deviations in the back trajectories. Therefore non-random clumped dispersal of quite high residuals and the inconsistency in the retrospective analysis lead to unacceptable uncertainty.

In order to eliminate the possible effect of the tuning data on the analysis, the same data were analysed without tuning using separable VPA (Fig. 6.5.4.1.3.4.). However the retroskm, pective analysis of three assessment results displayed the same inconsistency in the parameters estimated (Figure 6.5.4.3.3.3).

Table 6.5.4.3.3.1 Diagnostics of XSA.

Catch data for 25 years 1988 to 2012. Ages 0 to 4.

fleet first age last age first year last year alpha beta
1 Turkish purse seiners 0 31988 2012

Tapered time weighting applied
Power = 3 over 20 years

Terminal population estimation :

Survivor estimates shrunk towards the mean F of the final 5 years or the 1 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2

Minimum standard error for populationestimates derived from each fleet = 0.3
Regression weights
year

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

year										
age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.020	0.169	0.070	0.123	0.269	0.085	0.135	0.081	0.084	0.209
1	0.466	0.960	0.277	0.517	0.727	0.628	0.352	0.529	0.604	0.355
2	1.704	2.326	2.250	1.816	2.055	2.462	1.322	2.042	1.828	0.308
3	0.793	0.683	0.820	0.704	0.512	0.657	0.544	0.482	0.465	0.378
4	0.793	0.683	0.820	0.704	0.512	0.657	0.544	0.482	0.465	0.378

XSA population number (Thousand)

year/age	0	1	2	3	4
2003	152532996	47363906	17746060	4960446	22
2004	100748831	39933525	13227912	1845022	25
2005	173624139	22720078	6800905	738406	22
2006	244019887	43262961	7661447	409621	24
2007	192991571	57661414	11478183	711902	31
2008	196057337	39411819	12396533	840030	25
2009	156855241	48125551	9354387	603787	29
2010	182410838	36604025	15051755	1424564	32
2011	222741194	44943052	9595536	1115633	221035
2012	243784205	54733772	10933867	881109	588100

Estimated population abundance at 1st Jan 2013

Age/year	0	1	2	3	4
2013	0	52829517	17079351	4589087	373442

Log catchability residuals

Age/y	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.650	2.734	1.991	0.885	1.193	0.631	0.692	1.469	0.003	-0.196	-0.425	-0.044	-0.325	-1.453	-1.422
1	3.031	2.131	0.244	0.986	1.831	0.896	0.313	0.394	0.208	0.219	0.174	0.426	-0.162	-0.601	-0.379
2	3.927	0.578	1.917	2.864	2.373	3.026	0.691	0.242	1.543	1.081	0.758	1.476	0.332	0.671	0.768
3	4.010	0.586	1.957	2.927	2.410	3.079	1.669	-1.922	0.362	0.177	0.070	0.112	0.009	0.017	0.059

year										
age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	-1.480	0.552	-0.479	0.111	1.196	-0.089	0.469	0.150	0.216	1.119
1	-0.421	0.696	-1.057	-0.198	0.661	0.164	-0.356	0.280	0.503	0.005
2	1.300	2.110	1.784	1.515	2.189	2.253	1.264	2.188	2.041	-0.233
3	0.127	0.142	0.123	0.074	0.121	0.113	0.040	0.063	0.084	-0.029

Regression statistics

Ages with q dependent on year class strength

[1] "0.916057690604415" "8.78014760825956"

scaledWts survivors yrcls			
Turkish purse seiners	0.067	179255582	2012
fshk	0.024	80938520	2012
nshk	0.909	47751478	2012

Age 1 Year class =2011			
Turkish purse seiners	0.909	17168887	2011
fshk	0.091	8911800	2011

Age 2 Year class =2010			
Turkish purse seiners	0.483	3635867	2010
fshk	0.517	252078	2010

Age 3 Year class =2009			
Turkish purse seiners	0.968	362829	2009
fshk	0.032	465549	2009

Table 6.5.4.3.3.2 XSA results

Slot "stock.n":

An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year

age	1995	1996	1997	19981999	2000	
0	6.8149e+08	6.9554e+08	2.1309e+09	9.7527e+08	5.5547e+08	6.7571e+08
1	2.6827e+08	1.7980e+08	1.8423e+08	5.6788e+08	2.5914e+08	1.4733e+08
2	2.1852e+08	1.1164e+08	7.1354e+07	7.4672e+07	2.4344e+08	9.8669e+07
3	3.7537e+07	8.1884e+07	4.4401e+07	2.7355e+07	2.9580e+07	1.0230e+08
4	1.2490e+02	1.3123e+02	1.2315e+02	2.0104e+03	8.7068e+02	2.2734e+03

year

age	2001	2002	2003	20042005	2006	
0	6.1262e+08	2.2904e+08	1.8486e+08	1.2185e+08	2.3818e+08	3.6944e+08
1	1.7774e+08	1.6303e+08	5.9173e+07	4.8041e+07	3.1583e+07	6.2487e+07
2	6.3327e+07	7.6485e+07	5.6641e+07	1.9058e+07	1.0098e+07	1.1204e+07
3	3.4971e+07	1.6468e+07	2.1945e+07	1.6755e+07	3.1889e+06	8.5792e+05
4	5.5730e+01	4.7395e+01	4.4857e+01	2.2977e+01	2.1704e+01	1.9520e+01

year

age	2007	2008	2009	20102011	
0	2.1427e+08	2.4075e+08	1.8871e+08	2.3530e+08	8.0592e+07
1	9.5759e+07	5.3551e+07	6.3194e+07	4.8803e+07	6.1351e+07
2	1.6685e+07	1.9822e+07	1.4019e+07	1.9294e+07	1.4599e+07
3	9.3549e+05	1.2603e+06	1.2748e+06	1.8455e+06	6.1347e+05
4	1.7796e+01	1.8043e+01	2.1314e+01	1.6490e+01	2.5342e+03

Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year

age	1995	1996	1997	1998	1999	2000	2001
0	0.0124312	0.0085060	0.0023823	0.0053390	0.0071144	0.0154383	0.0038176
1	0.0666895	0.1142013	0.0930777	0.0370358	0.1556076	0.0343791	0.0332229
2	0.1715899	0.1120542	0.1487609	0.1159971	0.0569834	0.2272464	0.5368689
3	0.1231461	0.1168997	0.1249961	0.0789308	0.1098051	0.1352845	0.2966767
4	0.1231461	0.1168997	0.1249961	0.0789308	0.1098051	0.1352845	0.2966767

year

age 2002	2003	2004	2005	2006	2007	2008	
0	0.0334451	0.0275482	0.0301677	0.0180598	0.0301620	0.0666201	0.0175491
1	0.2472080	0.3229593	0.7497471	0.2263740	0.5104384	0.7650641	0.5302094
2	0.4385460	0.4080580	0.9778178	1.6555554	1.6729248	1.7731489	1.9339845
3	0.3576156	0.3815168	0.9127624	0.9955420	1.1814541	1.3904740	1.3558778
4	0.3576156	0.3815168	0.9127624	0.9955420	1.1814541	1.3904740	1.3558778

year

age	2009	2010	2011
0	0.0324226	0.0242630	0.0195822
1	0.3764053	0.3968244	0.5427956
2	1.2177031	2.6384187	1.9586556
3	1.0241599	1.6116570	1.3826148
4	1.0241599	1.6116570	1.3826148

units: f

Slot "harvest.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year

age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

units: NA

Slot "m.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

	year																
age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

units: NA

Slot "name":
[1] "BLACK SEA ANCHOVY Total,2011,COMBSEX,PLUSGROUP"

Slot "desc":
[1] "Imported from a VPA file. (BSAn00IN_NEW.DAT). Tue Nov 06 16:16:43 2012 + FLAssess: "

Slot "range":

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
0	4	4	1995	2011	1	3

Stock summary

	ssb	fbar	rec	catch	landings
1	4803931.2	0.12047517	681488950	385579.2	385579
2	3707164.5	0.11438506	695544114	277730.2	277730
3	2881877.4	0.12227822	2130880321	219496.2	219496
4	5782490.2	0.07732121	975274503	201149.0	201147
5	4919392.7	0.10746539	555465921	314680.2	314679
6	3114374.4	0.13230333	675708794	267921.0	267921
7	2327159.7	0.28892282	612624960	297797.2	297797
8	1812160.9	0.34778985	229042545	347446.2	347446
9	1288193.3	0.37084470	184862359	277184.2	277184
10	818696.5	0.88010909	121849232	316899.2	316899
11	426396.0	0.95915717	238176266	128883.2	128883
12	633458.5	1.12160576	369444518	225268.7	225268
13	887134.0	1.30956231	214274541	379618.6	379618
14	686900.8	1.27335725	240749101	260829.8	260830
15	672590.0	0.87275609	188709926	195617.6	195617
16	663637.7	1.54896671	235301847	248048.9	248049
17	669281.7	1.29468868	80591931	238153.4	238153

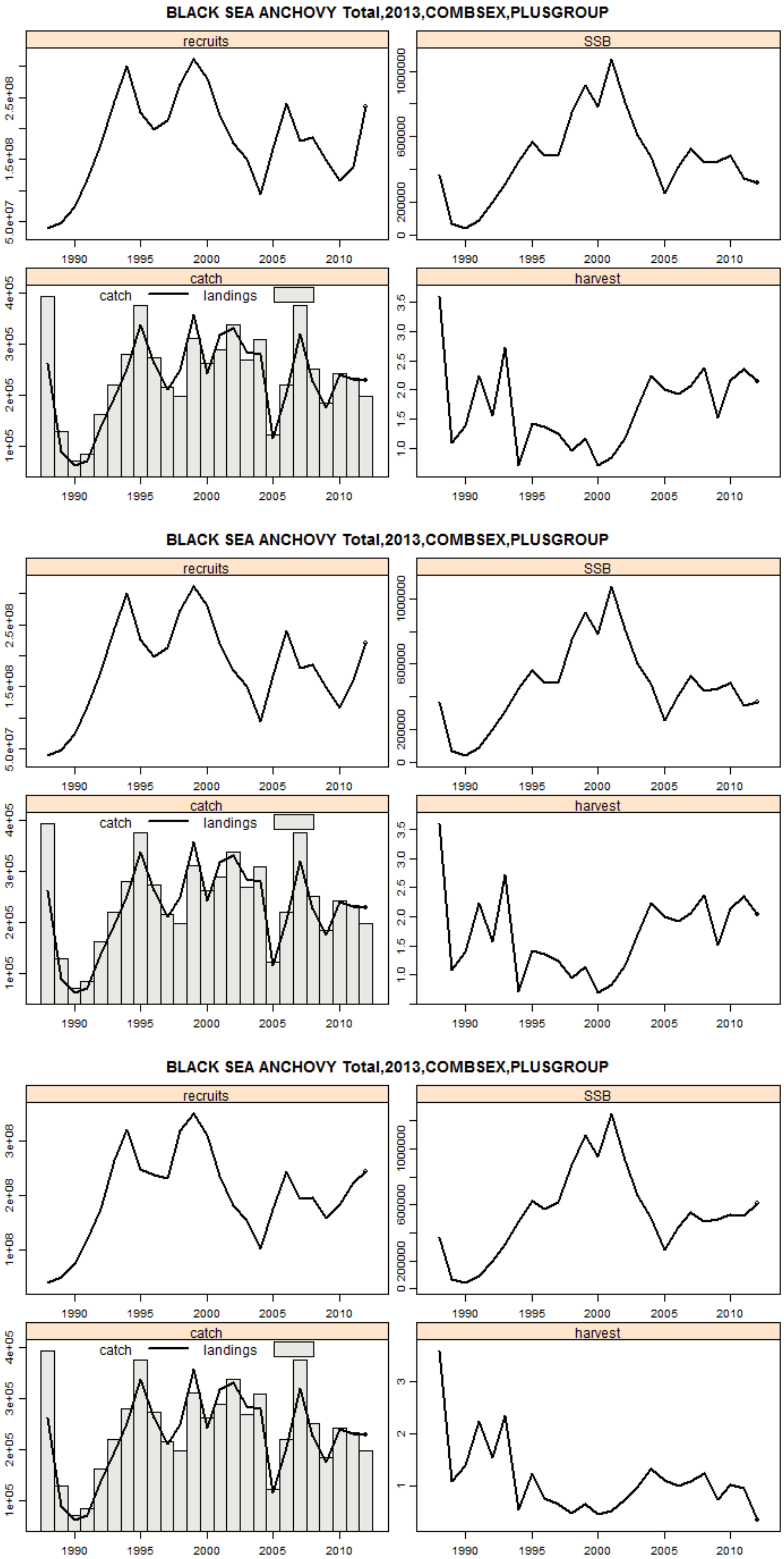


Figure 6.5.4.3.3.1. Summary of trends in stock parameters of anchovy using different levels of shrinkages in the Black Sea (top = SE 0.5; middle = SE 1; bottom = SE 2).

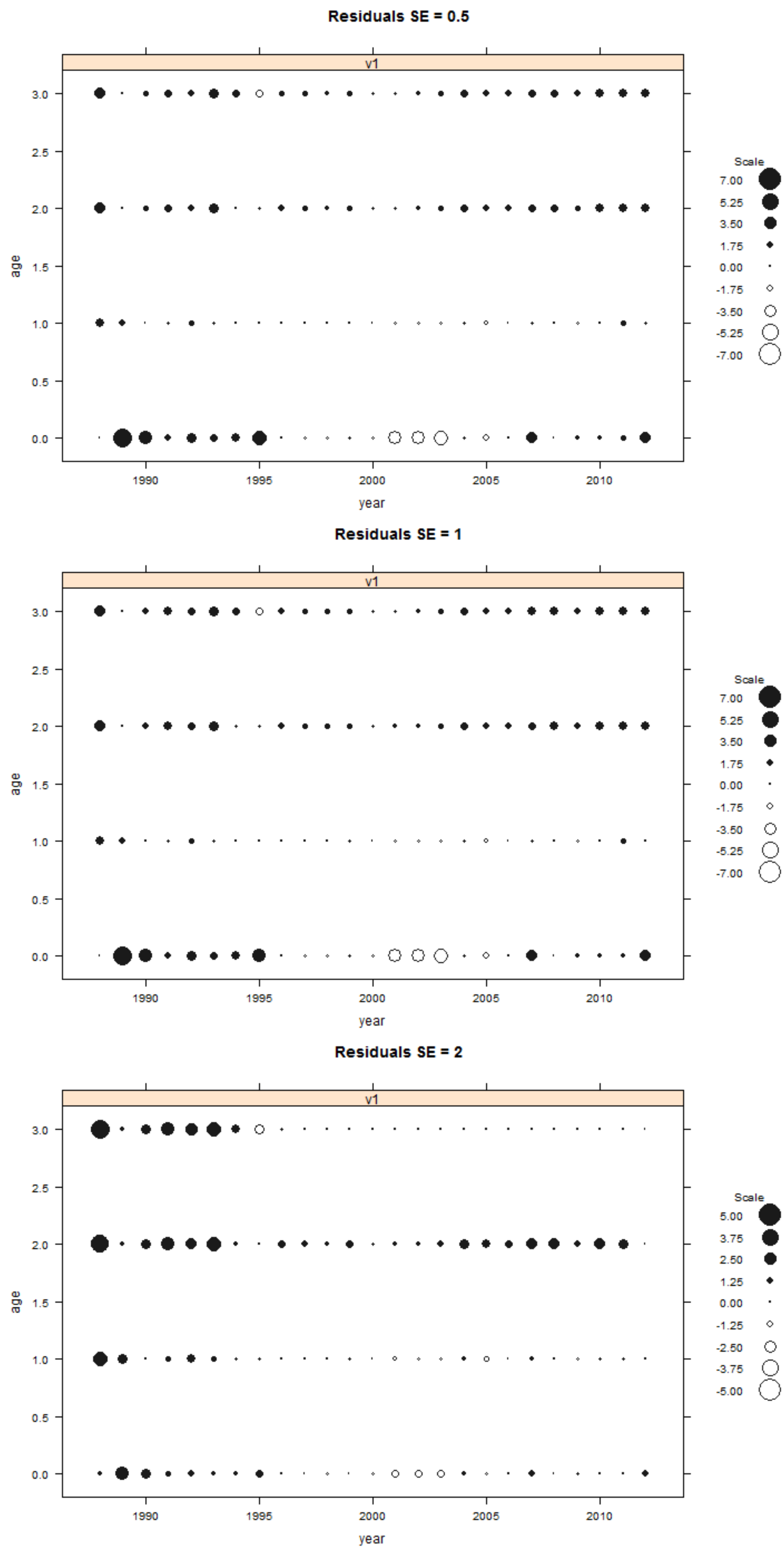


Figure 6.5.4.3.3.2. Tuning results. Log transformed residuals of catchability with different shrinkage (top = 0.5; top middle =1, bottom = 2)

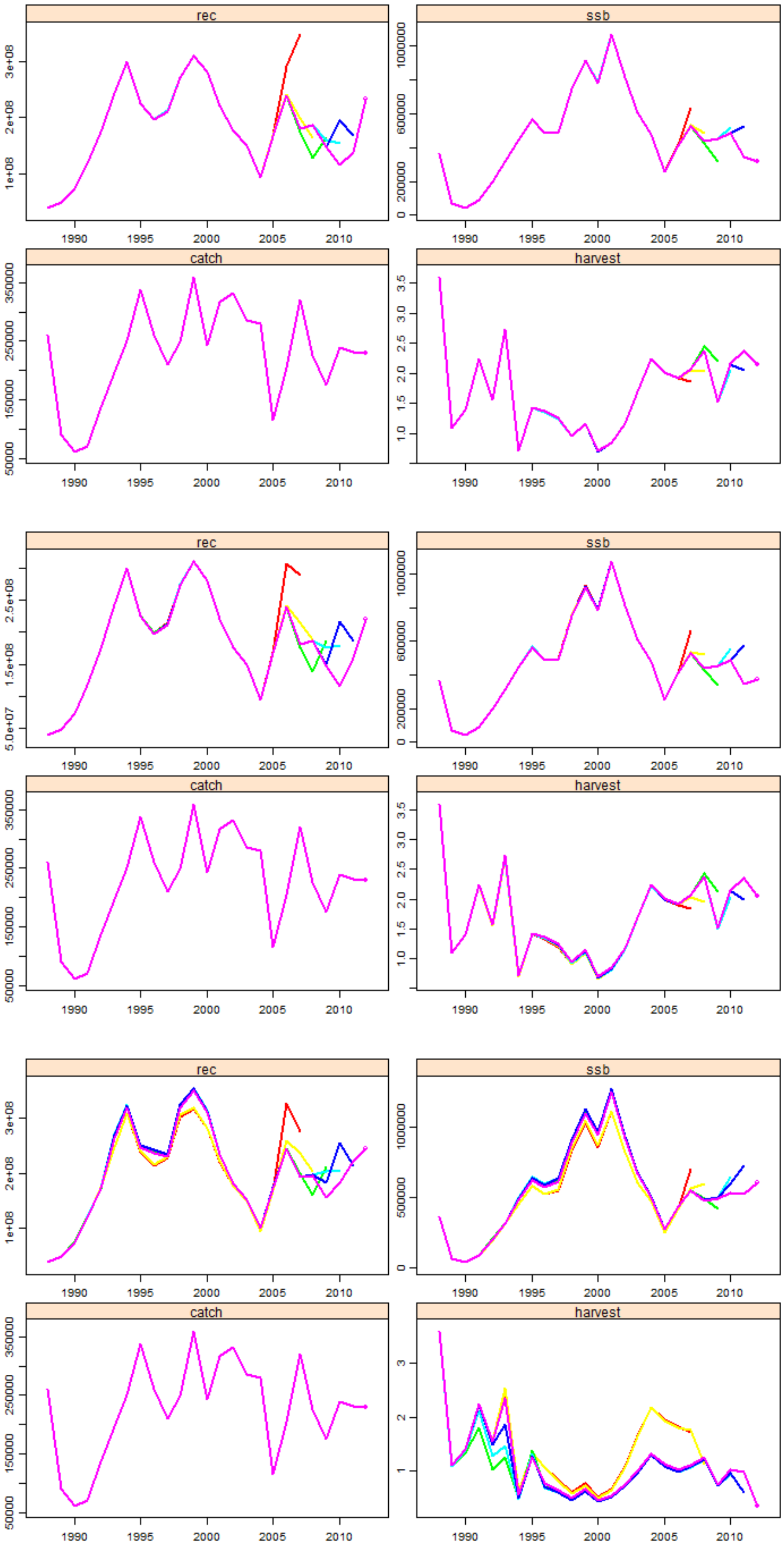


Figure 6.5.4.3.3.1. Retrospective analysis of anchovy stock parameters with different shrinkage (top = 0.5; top middle =1, bottom

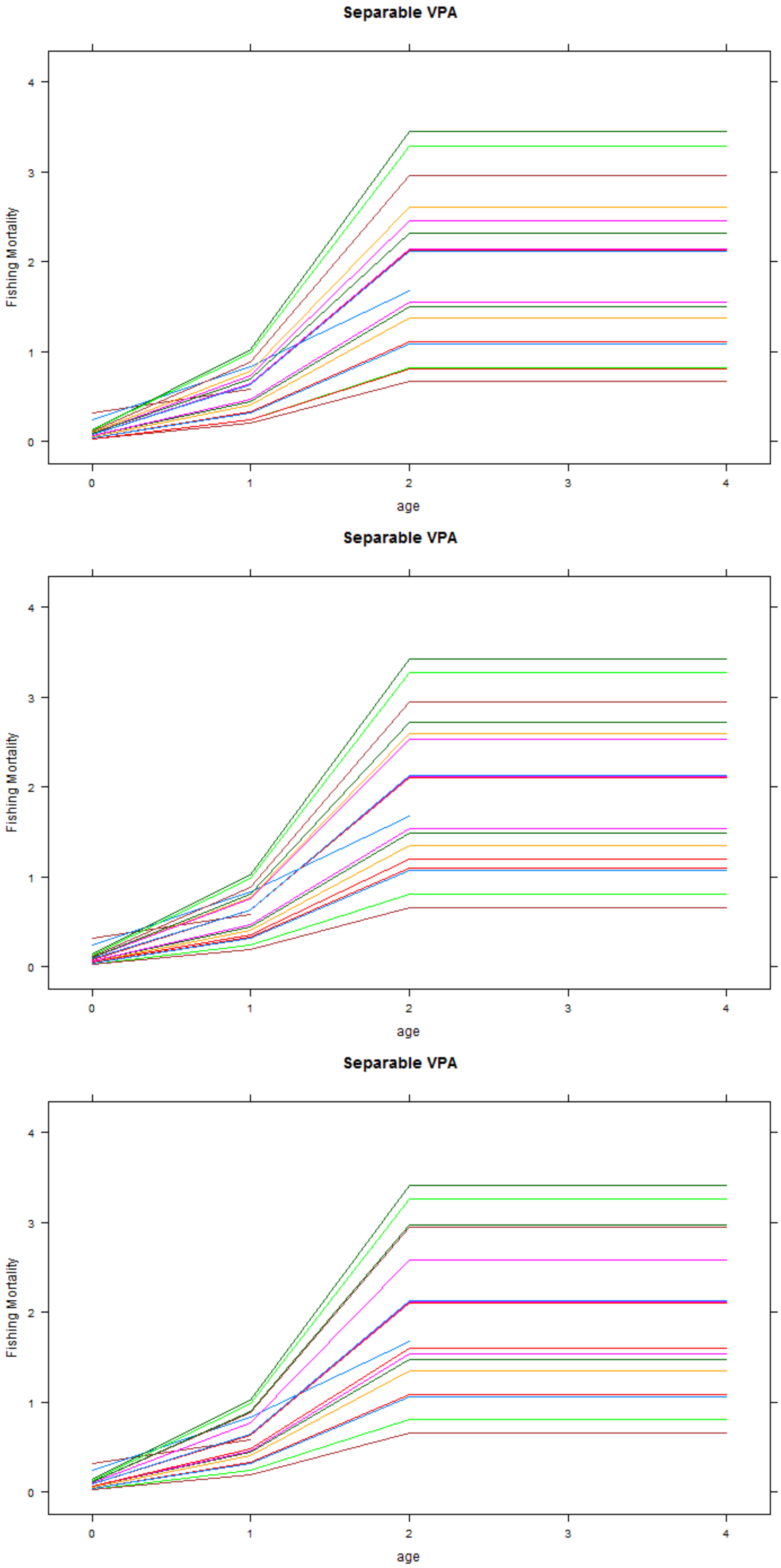


Figure6.5.4.3.3.2. Separable VPA analyses on three levels of F terminal.

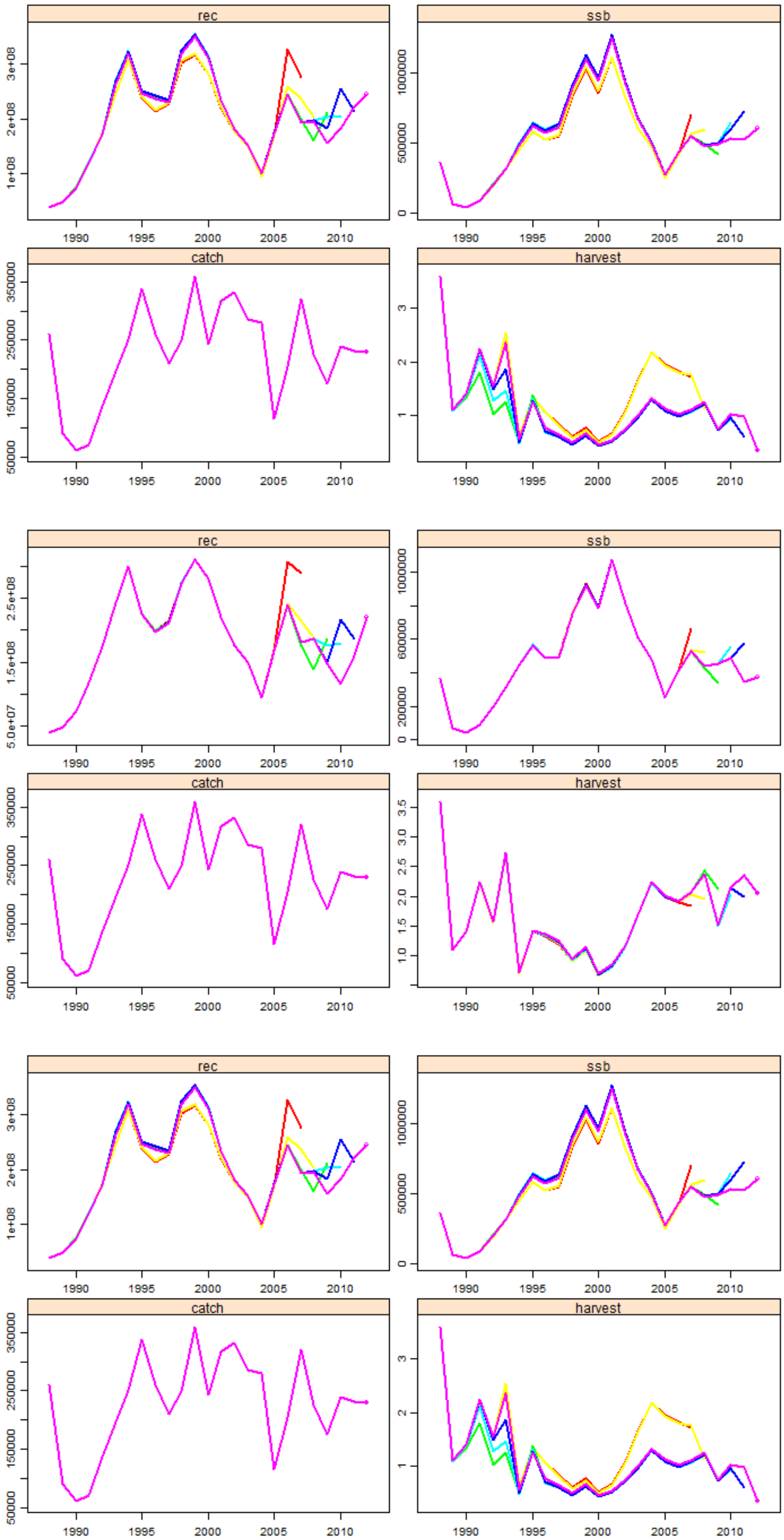


Figure 6.5.4.3.3.3. Retrospective analysis of sVPA asseement of anchovy stock with different terminal F values shrinkage (top = 0.8; middle =1.2, bottom = 1.6)

Finally, as the final attempt to assess the anchovy stock non-equilibrium stock production model was applied to the catch and effort data. The results of the analysis are given under Table 6.5.5. In this case, the residuals distributed randomly (Figure 6.5.4.3.3.). The estimated CPUE captured the general fluctuation pattern very roughly and therefore the estimated contrast index is not very high (0.48; Table 6.5.5). The model suggested that the F_{msy} was exceeded between 2000 and 2008. However current F is currently below the level leading to MSY. The Biomass was sharply reduced between 2000 and 2006; and recovered lately. When the output of the model, such as Fishing Mortality and the Biomass estimated by the model is compared with those estimated by the earlier models no consistency was found.

Table 6.5.4.3.3.3. ASPIC Results - Comparison Of Logistic And Generalized Models

Model	**Code**	**Exp**	**Bmsy/K**	**B1/K**	**MSY**	**K**	**q1**	**Objective fn.**	**AIC_c**
Logistic	30	2.00	0.500	2.560E+00	2.567E+05	5.000E+05	2.307E-03	5.051E+00	-2.998E+01
Generalized	41	6.04	0.700	3.626E-01	2.760E+05	1.213E+06	1.026E-03	5.223E+00	-2.599E+01

Test of H_o, exponent = 2.00: Fit of generalized model not better than logistic. Fail to reject Ho.

Table Goodness-Of-Fit And Weighting (Non-Bootstrapped Analysis)

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Inv. var. weight	R-squared in CPUE
Loss(0) Penalty for B1 > K	0.000E+00	1	N/A	0.000E+00	N/A	
Loss(1) F and Landings	5.223E+00	25	2.271E-01	1.000E+00	1.000E+00	0.087

TOTAL OBJECTIVE FUNCTION, MSE, RMSE: 5.223 2.611E-01 5.110E-01

Estimated contrast index (good=0.5, best=1.0): 0.4839 Mean of B coverage proportions > and < Bmsy
Estimated nearness index (best=1.0): 1.0000 Proportional closeness of B to Bmsy

Table Model Parameter Estimates (Non-Bootstrapped)

Parameter	Estimate		User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1988)	3.626E-01	5.000E-01	9.000E-01	1	1
MSY	Maximum sustainable yield	2.760E+05	2.500E+05	2.039E+05	1	1
K	Maximum population size	1.213E+06	7.000E+05	1.224E+06	1	1
Phi	Shape of production curve (Bmsy/K)	0.7000	5.000E-01	4.551E-01	1	1
--------- Catchability Coefficients by Data Series ---------------						
q(1)	F and Landings	1.026E-03	1.000E-03	6.704E-04	1	1

Management And Derived Parameter Estimates (Non-Bootstrapped)

MSY	Maximum sustainable yield	2.760E+05	----	----
Bmsy	Stock biomass giving MSY	8.491E+05	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	3.251E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	6.0440	----	----
g	Fletcher's gamma	1.712E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2013)/Bmsy	1.022E+00	----	----
F./Fmsy	Ratio: F(2012)/Fmsy	7.130E-01	----	----
Fmsy/F.	Ratio: Fmsy/F(2012)	1.402E+00	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2013	2.745E+05	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	9.947E-01	----	----
Ye.	Equilibrium yield available in 2013	2.756E+05	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)

...as proportion of MSY	9.985E-01	----	----

--------- Fishing effort rate at MSY in units of each CE or CC series ---------
fmsy(1)   F and Landings   3.170E+02 Fmsy/q(1) Fmsy/q(1)

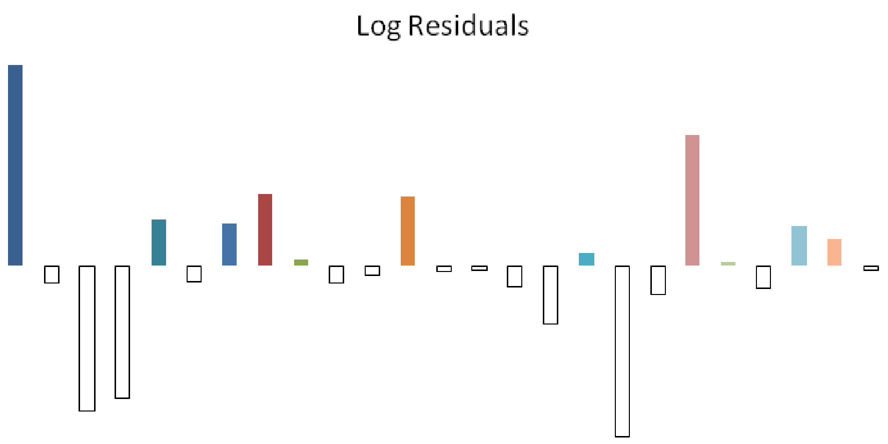


Figure 6.5.4.3.3.6.Unweighted log residual plot for anchovy fishery

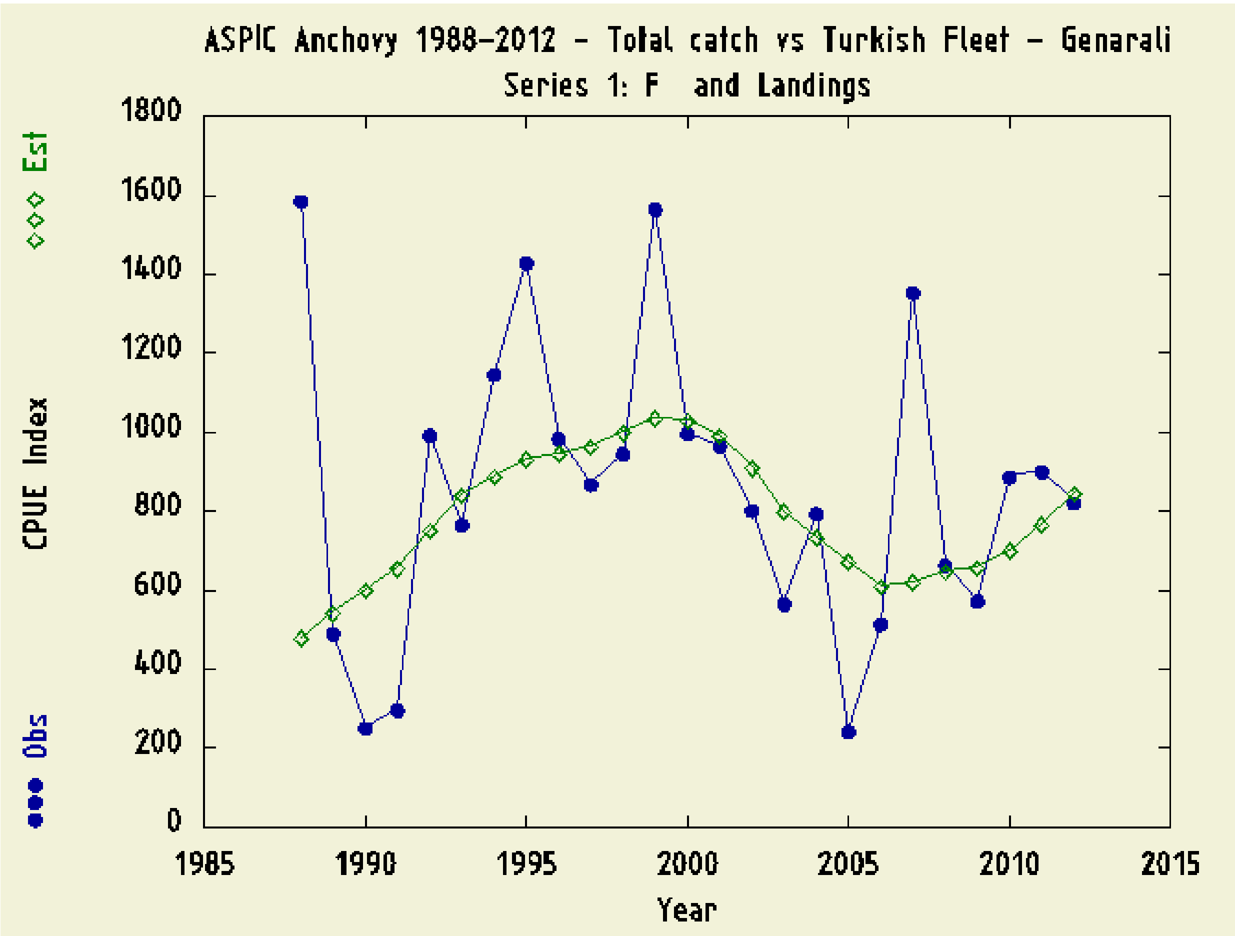


Figure6.5.4.3.3.7.Observed (blue dots) and estimated (green diamonds) CPUE

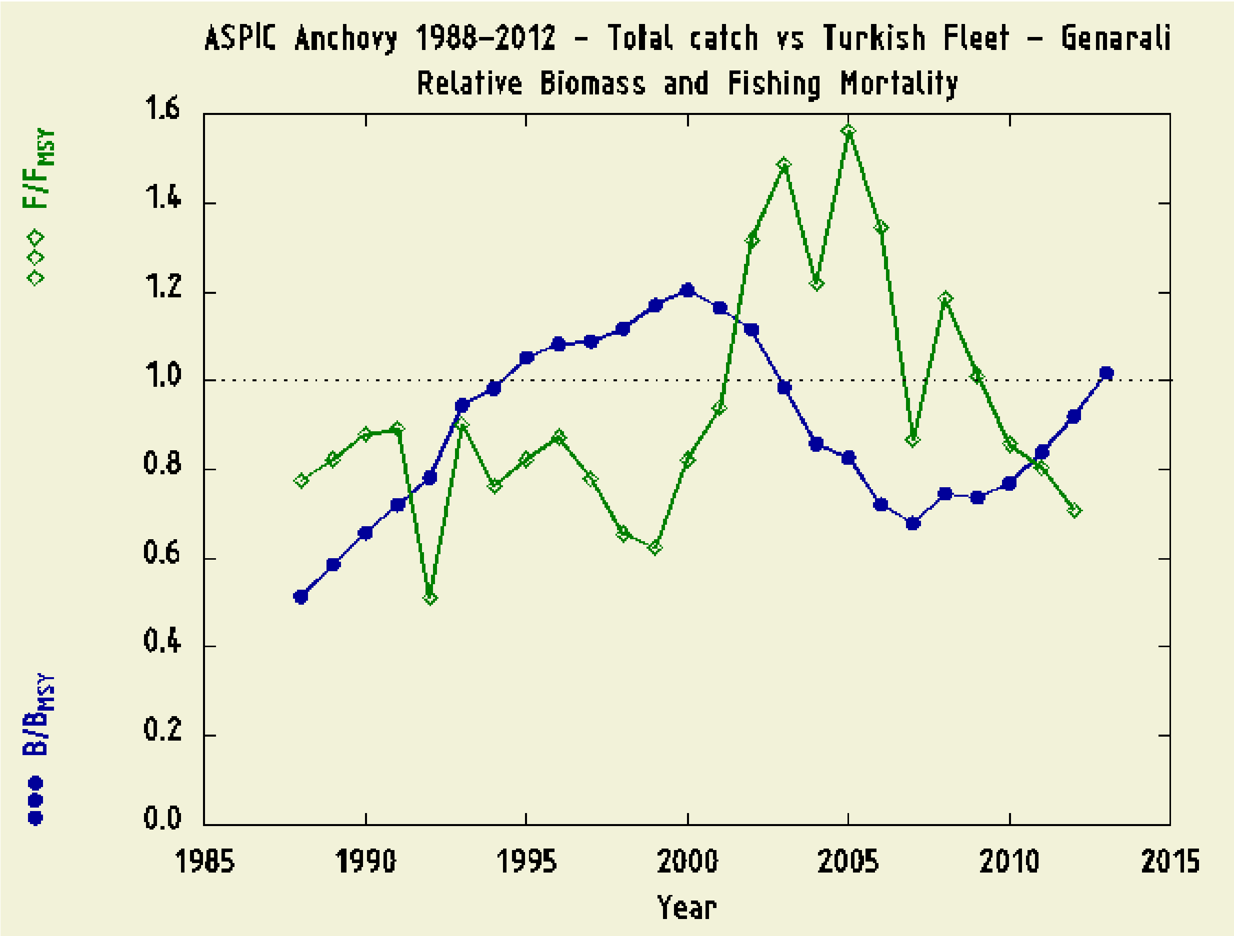


Figure 6.5.4.3.3.8. Time Plot of Estimated F/Fmsy and B/Bmsy (dashed line = 1.0)

6.5.5 *Short term prediction of stock biomass and catch*

The assessments carried out for the Black Sea anchovy could not produce reasonable and reliable outputs. It is possible that XSA and SVPA do not perform well with such a short living species - F start at age 3 years, and cannot resolve exploitation pattern (selectivity at age, partial recruitment). In future the EWG should look for more flexible and robust methods that work on the whole catch-at-age matrix. Tuning data are also judged as not very reliable as coming from purse seine fishing fleet. The major deficiency in this assessment is the lack of long time series data produced by scientific surveysthat needs to be used to adjust the analytical population models.

6.5.6 Medium term prediction of stock biomass and catch

The STECF EWG 13-12did not undertake medium term projections.

6.5.7 Long term predictions

No analyses were undertaken.

6.6 Piked Dogfish in the Black Sea

6.6.1 *Biological features*

6.6.1.1 *Stock Identification*

Piked dogfish inhabits the whole Black Sea shelf at the water temperatures 6 – 15º C – Fig. 6.6.1.1.1 and Fig. 6.6.1.1.2. It undertakes extensive migrations. In autumn feeding migrations are aimed at the grounds of the formation of the wintering concentrations of anchovy and horse mackerel in the vicinity of the Crimean, Caucasus and Anatolian coasts. With their disintegration picked dogfish disperses all over the shelf. Reproductive migrations of viviparous picked dogfish take place towards the coastal shallows with two peaks of intensity – in spring and autumn. The autumn migration for reproduction covers more individuals usually. The major grounds for reproduction of picked dogfish in the Ukrainian waters are located in Karkinitsky Bay, in front of Kerch Strait and in Feodosia Bay.

Piked dogfish belongs to long-living and viviparous fish; therefore reproduction process includes copulation and birth of fries. Near the coasts of Bulgaria, Georgia, Romania, Russian Federation and Ukraine the intense spawning season is in March-May. Two peaks of birth of juveniles can be distinguished – spring period (April-May) and summer-autumn (August-September, Serobaba et al., 1988). To give birth of juveniles the females approach the coastal zone in depth 10 – 30 m (Maklakova, Taranenko, 1974). At this time males keep separately from females in depth 30 – 50 m. The birth of picked dogfish juveniles takes place at the temperature of water 12 – 18°C.

In autumn piked dogfish aggregates into large schools, accompanying anchovy and horse mackerel, which migrate to wintering grounds along eastern and western coast. During wintering the densest concentrations of picked dogfish are observed, where picked dogfish feeds intensively. They are associated, above all, with major wintering areas of anchovy in the waters of Georgia and Turkey. In the North-western Black Sea in the waters of Ukraine and Romania in depth from 70-80 m down to 100-120 m abundant wintering concentrations of picked dogfish are also observed, where they are located on the grounds of whiting and sprat concentrations (Kirnosova, Lushnicova, 1990).

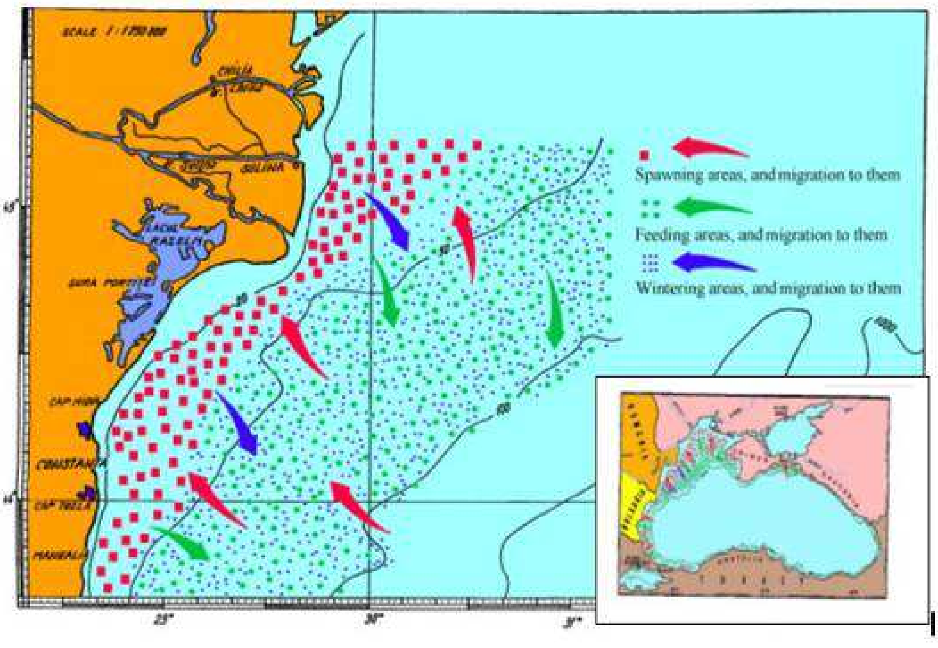


Fig. 6.6.1.1.1 Distribution and migration routes of the piked dogfish at Romanian littoral (Radu et al.,2009b, 2010a).

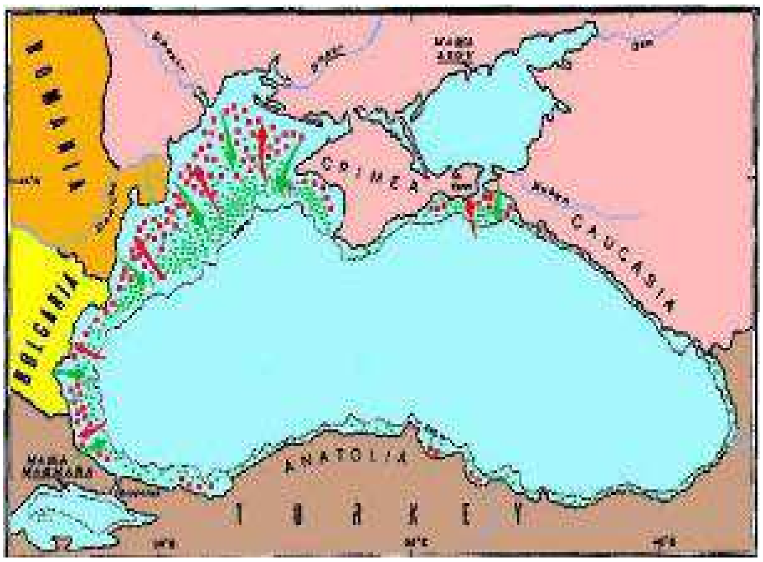


Fig. 6.6.1.1.2 Distribution and migration routes of the piked dogfish at Black Sea level.

6.6.1.2 *Growth*

Piked dogfish is a major demersal predator, reaching the Black Sea the length of about 1.50 m. According to investigations conducted in former USSR waters, Kirnosova, (1993) found that the piked dogfish maximum age is 20 years. The parameters in VBGF and natural mortality parameters are:

<u>Males:</u> K=0.029 t_0=-3.84; L_∞=272 cm; W_∞=47 kg; M=0.20÷0.23

<u>Females:</u> K=0.026 t_0=-3.32; L_∞=303 cm; W_∞=196 kg; M=0.15÷0.20

Age and length, at which 50% of individuals are mature, are 10.49 years and 87.57 cm for males and 11.99 years and 102.97 cm for females, respectively. Mean biennial fecundity is 19.4 eggs and 12.9 pups. The linear relationship between fecundity and length is: F_e = 0.09 x TLp + 2.12 (r = 0.5) for pups and F_o = 0.27 x T Lp - 21.59 (r = 0.7) for eggs (Demirhan and Seyhan, 2007).

Ukrainian data for the period 1971-2001 are: L_∞=282; t_0 = -3.6684 (year); a = 0.00000677; b =2.9593. For period 2002 – 2012 a= 0.00000640; b= 3.0000

Romanian data for 2011 are the following: L∞ =136.3 cm; t_0=−1.30 (year); a = 0.0117; b = 2.76694; k = 0.191(year^{-1}); M = 0.258.

In 2012, L∞ =134.74cm; t_0=−1.13684 (year); a = 0.0169769; b = 2.696436; k = 0.153(year^{-1}); M = 0.257.

6.6.1.3 *Maturity*

Life-history parameters and food diet of picked dogfish (*Squalus acanthias*) from the SE Black Sea were studied (Demirhan and Seyhan, 2007). Picked dogfish at age 1 to 14 years old were observed, with dominance of 8 years old individuals for both sexes. The length–weight relationship was W=0.0040*$L^{2.95}$and the mean annual linear and somatic growth rates were 7.2 cm and 540.1 g, respectively. The estimated parameters in VBGF were: W_∞=12021 (g), L_∞=157 (cm), K=0.12 (year^{-1}) and t_0=−1.30 (year). The size at first maturity was 82 cm for males and 88 cm for females. Mean biennial fecundity was also found to be 8 pups per female. The relationships fecundity–length, fecundity–weight and fecundity–age were found to be:

F=−17.0842+0.2369*L (r=0.93)

F=0.3780+0.0018*W (r=0.89)

F =−0.7859+1.1609*A (r=0.94), respectively.

In conformity with Ukrainian data, the maturity ogive for last years is the following:

Year/ Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.25	0.45	0.55	0.75	0.95	1.00	1.00	1.00	1.00	1.00

Maturity ogive from Romanian data

Year/ Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2011	0.00	0.00	0.45	0.70	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

6.6.2 Fisheries

6.6.2.1 *General description*

In the Black Sea the largest catches of picked dogfish are along the coasts of Turkey, although this fish is not a target species of fisheries, being yielded as by-catch in trawl and purse seine operations mainly in the wintering period. In the 1989-1995 annual catches of Turkey are 1055-4558 t (Shlyakhov, Daskalov, 2008). In subsequent years, they have decreased about 2 times and did not exceed 2400 t. In the waters of Ukraine most of piked dogfish is harvested in spring and autumn months by target fishing with gill-nets of 100 mm mesh-size, long-lines, and as by-catch of sprat trawl fisheries. As in Turkish waters, in the last 20 years the maximum annual catches of picked dogfish are observed in 1989-1995, reaching 1200-1300 t. After 1994 the catches went down being between 20 and 200 t. In the rest of countries piked dogfish is harvested mainly as by-catch, annual catches are usually lower than the Ukraine. The maximum annual catches of picked dogfish in 1989-2005 were: Bulgaria - 126 t (2001), Georgia - 550 t (1998), Romania - 52 t (1992), Russian Federation - 183 t (1990). It should be noted that in the waters of Bulgaria, the highest catches were observed in the early 2000's. In Romania dogfish is caught mainly as by-catch of the sprat trawl fishery. The catches decreased very much because of decreasing of the trawling effort (Maximov et al., 2008b, 2010b; Radu et al., 2009b, 2010a,b).

In Turkey piked dogfish lost its commercial importance in recent years. In the last 20 years, the decrease of dogfish landing may be may be due to over-fishing (Demirhan , phD thesis,)

In the last three years increased the importance of the catches in Bulgaria, these being around 40% from total Black sea catches/

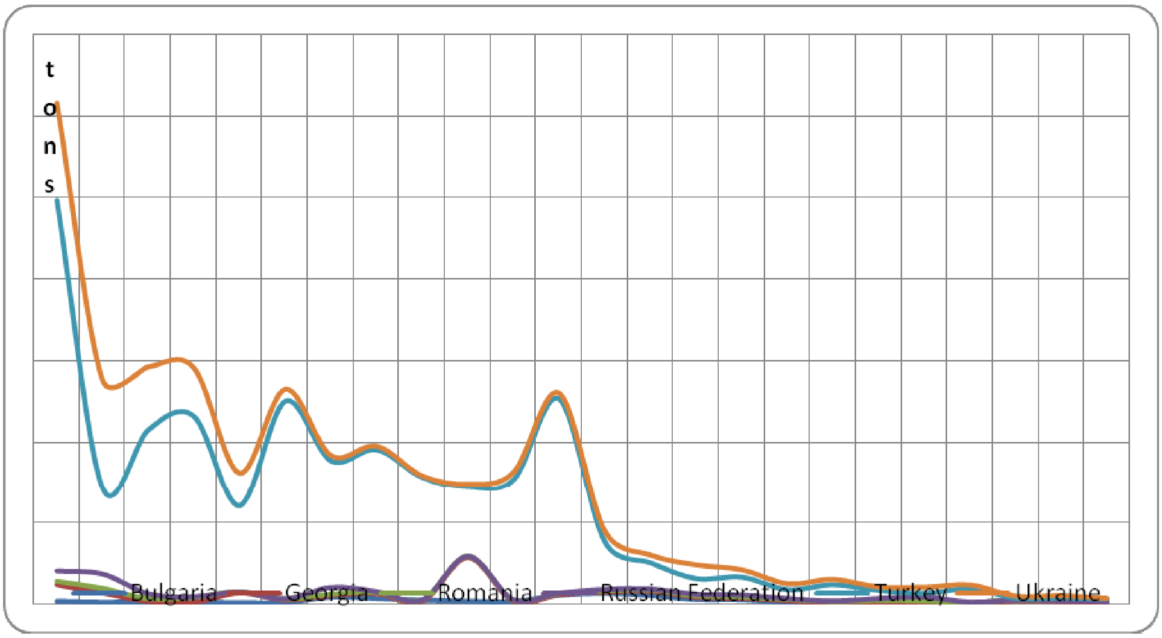


Fig. 6.6.2.1.1- Spiny dogfish catches in the Black Sea area (t)

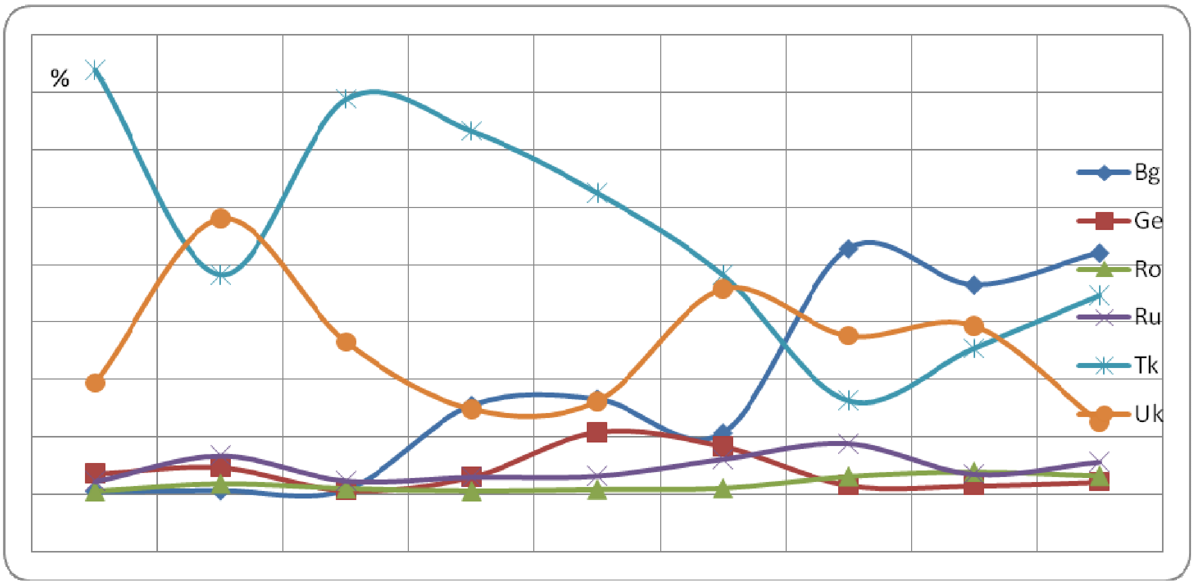


Fig. 6.6.2.1.2 - Proportion (%) by countries) of the catches for the years taken into consideration for assessment

6.6.2.2 *Management regulations applicable in 2010, 2011and 2012*

Romanian fisheries regulatory framework includes between others the following laws:

- Law on Fishing Fund, Fishery and Aquaculture No. 23 /2008;
- Annual Order on the Fishing Prohibition;
- Order no. 342/2008 on minimal size of the aquatic living resources;

- Order nr. 449/2008 on technical characteristics and practice conditions for fishing gears used in the commercial fishing.

Regarding Spiny dogfish, for protecting the reproduction and rehabilitation of the stock were adopted the following measures (Radu G. and Nicolaev S., 2010, 2011, 2012):

- in period April - June, 60 days, the fishing is prohibited;
- it is banned to use the trawl in marine zone under the 20 m depths;
- mesh size for dogfish gillnets: a = 100mm, 2a = 200 mm;
- minimum admissible length in catches is 120cm (TL)

In the Black Sea Fishes list IUCN status presented on the Black Sea Commission website (www.blacksea-commission.org) is included and categorized *Squalus acanthias* as follows (Table 6.6.2.2.1) in the BSC, 2011:

Table 6.6.2.2.1. The IUCN status of spiny dogfish in the Black Sea countries

Country	**BG**	**GE**	**RO**	**RF**	**TR**	**UK**
IUCN status	N/A	LC	NT	N/A	EN	NT

LC - least concerned; NT- near threatened; EN- endangered; N/A – no data

6.6.2.3 *Catches*

6.6.2.3.1 *Landings*

The landings of Piked dogfish by countries are given on Table 6.6.2.3.1.1.

Table 6.6.2.3.1.1. Piked dogfish landings by countries (FAO Fisheries Statistics, GFCM Capture Production 2006 – 2008, BSC data, input from experts).

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	TOTAL
1989	28	217.000	30	135.000	4558	1191.000	**6159.000**
1990	16	128.000	45	183.000	1059	1330.000	**2761.000**
1991	21	18.000	26	67.000	2017	775.000	**2924.000**
1992	15	14.000	52	15.000	2220	595.000	**2911.000**
1993	12	131.000	6	5.000	1055	409.000	**1618.000**
1994	12	45.000	2	11.000	2432	148.000	**2650.000**
1995	80	31.000	7	90.000	1562	67.000	**1837.000**
1996	64	71.000	5	19.000	1748	44.000	**1951.000**
1997	40	1.000	5	9.000	1510	20.000	**1585.000**
1998	28	550.000	5	6.000	855	38.000	**1482.000**
1999	25	18.000	5	9.000	1478	94.000	**1629.000**
2000	102	21.000	5	12.000	2390	71.000	**2601.000**
2001	126	27.000	5	27.000	576	134.000	**895.000**
2002	100	65.000	5	19.000	316	97.000	**602.000**
2003	51.3	40.000	5	29.000	184	172.000	**481.300**
2004	47.2	31.000	5	34.000	211	93.000	**421.200**
2005	14.5	35.000	5	19.000	102	75.000	**250.500**
2006	6.226	10.000	9	17.000	193	67.000	**302.226**

2007	23.98	2.000	17	32.000	91	45.000	**210.980**
2008	22.75	0.400	10	59.000	35	79.000	**206.150**
2009	9.46	1.500	4	14.000	159	47.000	**234.960**
2010	42	1.500	3	8.540	16	27.000	**98.040**
2011	38.06	1.500	4	3.610	26.5	30.537	**104.207**
2012	28.67	1.50	2.14	4.00	25.00	9.00	**70.310**

6.6.2.3.2*Discards*

Discarding may play a major role in the catch of piked dogfish. However, the EWG 13-12 has no quantitative information.

6.6.2.4 Fishing effort

The EWG 13 12 has no quantitative information for all riparian countries. In 2011 and 2012 only Romania gives data regarding number of gillnets on vessel length:

Table 6.6.2.4.1Number of fishing gillnets for dogfish in the Romanian area

Vessel length (m)	Number of gillnets for dogfish in 2011	Number of gillnets for dogfish in 2012
< 6m	10	-
6-12 m	205	110
18-24 m	50	50
Total	265	160

6.6.2.5 *Commercial CPUE*

The EWG 13-12 has no quantitative information for all riparian countries. In last years, only Romania gives data regarding commercial CPUE for 2009-2012 period and CPUE in at sea surveys for 2010, 2011 and 2012.

Table 6.6.2.5.1Romanian CPUE in commercial fishing.

YEAR	**Fishing**	**CPUE**
2009		
LOA 6-12 m	gillnets	0.24 kg/gear/day
LOA 18-24 m	gillnets	0.40 kg/gear/day
LOA 24-40 m	gillnets	0.89 kg/gear/day
2010		
LOA 6-12 m	gillnets	0.18 kg/gear/day
2011		
LOA 6-12 m	gillnets	0.248kg/gear/day
LOA 18-24 m	gillnets	0.91 kg/gear/day
2012		
LOA 6-12 m	gillnets	0.26 kg/gear/day
LOA 12-18 m	gillnets	0.85 kg/gear/day
18-24	gillnets	0.46 kg/gear/day

Table 6.6.2.5.2 CPUE in the at sea surveys for Romanian Black Sea areas

YEAR	2010		2011		2012	
Period	Spring	Autumn	Spring	Autumn	Spring	Autumn
Range (kg/hour)	3.6 – 98.63	4.5 – 106.22	5.8 – 24.9	5.0 -24.83	1.1-19.2	1.5-134

6.6.3 Scientific Surveys

6.6.3.1 *Method 1: International and national surveys*

The following section describes results of various fisheries independent scientific surveys.

6.6.3.1.1*Geographical distribution patterns*

In Romanian waters the agglomerations are distributed on the entire shelf, but especially at depth deeper than 20m. Two peaks of intense spawning and of birth of juveniles are in spring and autumn period at Romanian littoral.

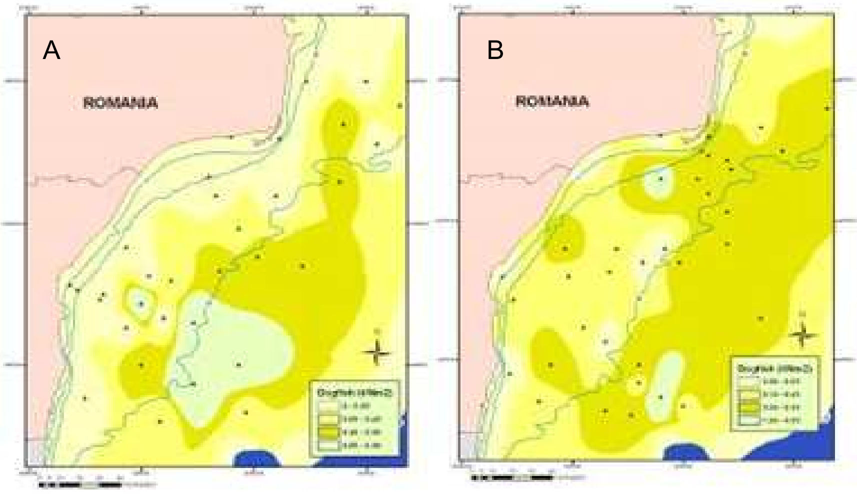


Fig. 6.6.3.1.1.1. Distribution of picked dogfish agglomeration during demersal trawl survey in 2009 (A - spring season, B - autumn season), Romanian Black Sea area.

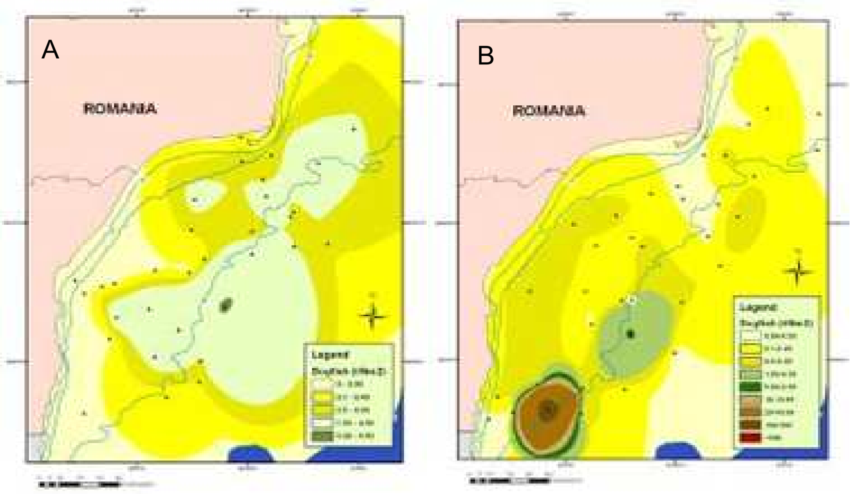


Fig. 6.6.3.1.1.2. Distribution of piked dogfish catches during demersal trawl survey in 2010 (A - spring season, B - autumn season), Romanian Black Sea area.

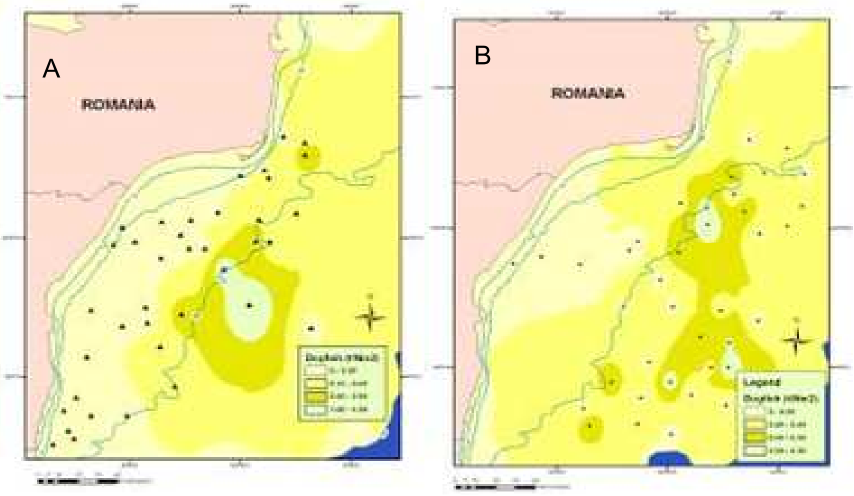


Fig. 6.6.3.1.1.3. Distribution of piked dogfish catches during demersal trawl survey in 2011 (A - spring season, B - autumn season), Romanian Black Sea area.

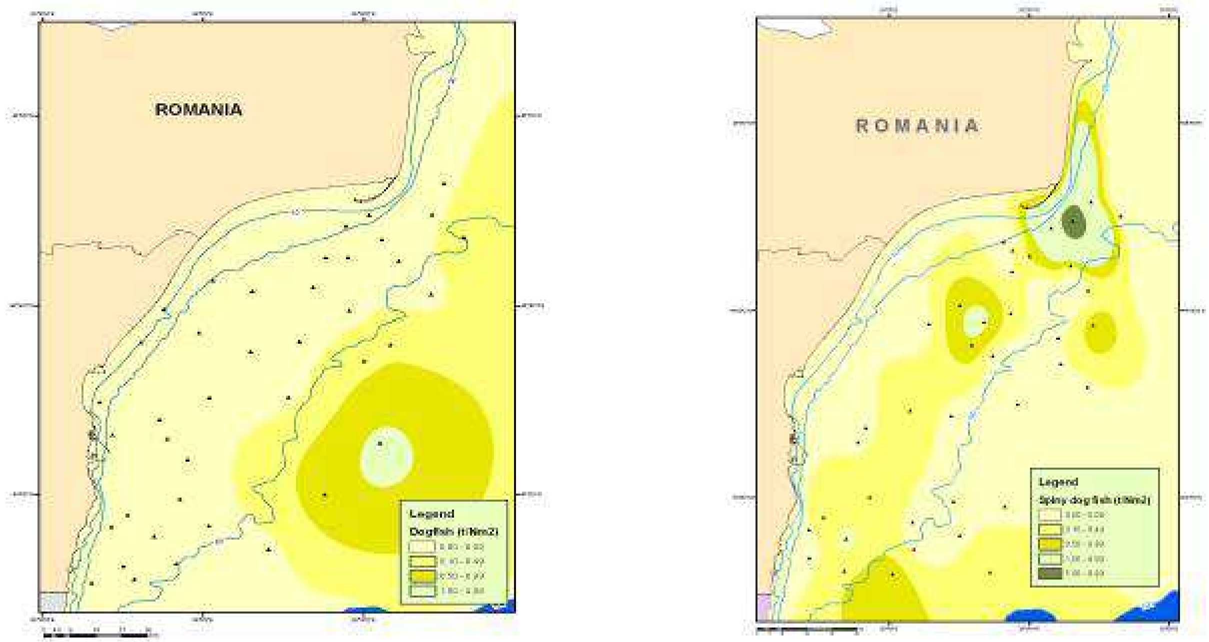


Fig. 6.6.3.1.1.4. Distribution of piked dogfish catches during demersal trawl survey in 2012 (A - spring season, B - autumn season), Romanian Black Sea area.

6.6.3.1.2*Trends in abundance and biomass*

In the former USSR and later in Ukraine, to assess the piked dogfish stock, the swept area technique using bottom trawl surveys, as well as dynamic model of an isolated population, were applied (Shlyakhov, 1997). The abundance and biomass of picked dogfish in the waters adjacent to Georgia, the Russian Federation and Ukraine were assessed. Whole population of picked dogfish in 1972 – 1992 was assessed by VPA. The obtained results from stock assessments for whole Black Sea (Prodanov *et al.*, 1997, Daskalov 1998, Fig.6.6.3.1.2.1), the former USSR and Ukrainian waters (Shlyakhov, Charova, 2006)in 1989 – 2005 are given in Table 6.6.3.1.2.1. According to the assessments, in 1989 – 2005 the stock of picked dogfish in the shelf area of the Black Sea and in Ukraine waters tends to be gradually reduced. Observed dynamics of stock corresponds with increasing CPUE in Turkish waters.

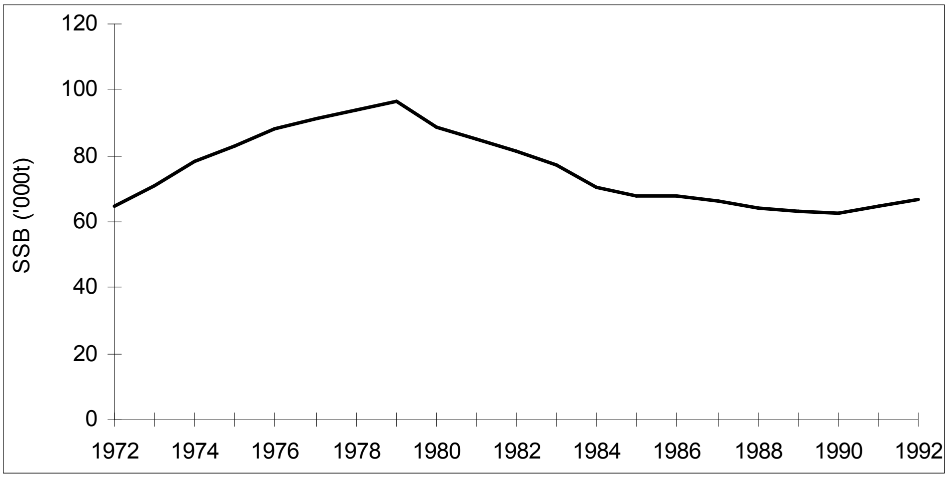


Fig. 6.6.3.1.2.1 Historical assessment of SSB by Daskalov (1998)

Table 6.6.3.1.2.1. Commercial stock of picked dogfish in the Black Sea and along the coast of the former USSR and in the water of Ukraine, th. tones.

Years	Whole Black Sea shelf	Waters of Ukraine, the Russian Federation and Georgia		Waters of Ukraine	
	VPA	Trawl survey	Modeling	Trawl survey	Modeling
1989	117.8	58.5	63.5	34.6	-
1990	112.9	58.7	63.2	48.8	-
1991	97.9	17.2/69.9*	64.0	14.4/58.5*	-
1992	90.0	62.9	60.3	56.9	-
1993	-	-	57.1	30.2	-
1994	-	-	52.9	36.0	42.1
1995	-	-	-	-	37.6
1996	-	-	-	-	32.1
1997	-	-	-	-	31.0
1998	-	-	-	32.0	30.8
1999	-	-	-	-	28.0
2000	-	-	-	-	24.3
2001	-	-	-	-	22.3
2002	-	-	-	-	21.0
2003	-	-	-	-	22.1
2004	-	-	-	-	22.3
2005	-	-	-	-	21.0

* stock assessment is reduced to the average area of the registration (survey) zone.

According to the assessments of Prodanov*et al.* (1997) and Daskalov (1998) picked dogfish stock has increased until 1981, after that it began to decrease. The authors explained the increase in picked dogfish with the increased abundance of main food species (whiting, sprat, anchovy and horse mackerel), and its subsequent reduction partially with intensification of the dogfish fishery during the period 1979 – 1984.

In Romanian waters the swept area method was applied for stock assessment of piked dogfish. Results for estimated piked dogfish biomasses in May and November of 2009- 2012 in Romanian waters are given on Tab. 6.6.3.1.2.2 - 6.6.3.1.2.9(Maximov et al.2010b,c; Radu et al. 2009 a,b, 2010a,b; Radu 2012). In May 2009 the biomass of dogfish was evaluated at 741 t, extrapolated to 967 t for the shelf till 50 Nm from the shore. In May

2010 the biomass of dogfish was evaluated at 2437 t, extrapolated to 5635 t for the shelf till 50 Nm from the shore. In the autumn period the biomass agglomeration increased at 2541 t (2009) and 13051 tons (2010).

In 2012, in the Romanian Black Sea area the biomass calculated has been of 1436.4 tons in spring and 1515.8 tons in autumn.

Table 6.6.3.1.2.2 Assessment of piked dogfish biomass in May 2009 by demersal trawl, Romanian Black Sea area.

No. polygon	Surveyedarea (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total t in polygon (t)	Notes
1	1,227.13	0.00	0.00	0.0	Extrapolated at 967 t for the shelf till 50 Nm from shore
2	242.25	0.27 – 0.43	0.35	84.78	
3	165.00	0.23 – 0.28	0.26	42.90	
4	116.00	0.28	0.28	32.48	
5	724.25	0.53 0.76	0.63	456.27	
6	478.25	0.23 – 0.28	0.26	124.35	
7	265.63	0.00	0.0	0.00	
Total	3,218.5			740.78	

Table 6.6.3.1.2.3 Assessment of dogfish agglomeration in the Romanian area in the period May –June 2010, sampling gear demersal trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon(t)	Total on the shelf (t)
1	630.50	0.00	0.00	0.00	Extrapolated at5635 tons for the shelf till 50 Nm from shore (about 5000 Nm2), including the new area (near Snake Island)
2	567.75	0.21-1.41	0.63	357.68	
3	216.75	0.24-0.68	0.47	101.87	
4	1155.00	0.56-5.62	2.11	2437.00	
Total	2570			2897.00	

Table 6.6.3.1.2.4. Assessment of picked dogfish biomass by demersal trawl in November 2009, Romanian Black Sea area.

No. polygon	Surveyed Area(Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total t in polygon (t)	Notes
1	926.25	0.26 – 0.81	0.41	379.76	Extrapolated at 2,541 t for the shelf till 50 Nm from shore
2	2,404.13	0.39 – 2.04	0.68	1,634.81	
Total	**3,330**			**2,015**	

Table 6.6.3.1.2.5Assessment of dogfish agglomeration in the Romanian area in the period October –November 2010, sampling gear demersal trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon(t)	Total on the shelf (t)
1	40	164.48	164.48	6579.2	Extrapolated at 13051 tons for the shelf till 50 Nm from shore (about 5000 Nm2), including the new area (near Snake Island)
2	56	5.82	5.82	325.9	
3	1201	0.00-0.89	0.46	552.5	
4	315	0.00	0.00	0.00	
5	570	0.00	0.00	0.00	
6	868	0.28-1.01	0.58	503.44	
TOTAL	**3050**			**7961.04**	

Table6.6.3.1.2.6Assessment of dogfish agglomeration in the Romanian area in the spring 2011, sampling gear demersal trawl

Range ofdepths (m)	0 - 30	30-50	50-70	Total

Area (Nm^2)	675	1050	500	2225
Range of t/ Nm^2	0.00 – 0.00	0.00 – 1.11	0.00 – 2.53	
Biomass (t)	00.00	205.8	316	522.3*

* extrapolated at 1173 tons

Table6.6.3.1.2.7 Assessment of dogfish agglomeration in the Romanian area in the autumn 2011, sampling gear demersal trawl

Range ofdepths (m)	**0 - 30**	**30-50**	**50-70**	**Total**
Area (Nm^2)	650	1225	1700	3575
Range of t/ Nm^2	0.00 – 0.00	0.00 – 1.53	0.00 – 2.53	
Biomass (t)	00.00	561.86	650.969	1212.8

* extrapolated at 1696 tons

Table6.6.3.1.2.8- Assessment of dogfish agglomerations in the period May 2012, demersal trawl survey , Romanian area

Depth range (m)	0 - 30m	30 – 50m	50-70 m	Total
Investigated area (Nm^2)	663.62	1065	517.37	2245.99
Variation of the catches (t/ Nm^2)	0.00-0.062	0.00-0.365	0.00-0.75	0.00-0.75
Average catch (t/ Nm^2)	0.005	0.016	0.432	
Biomass of the fishing agglomerations (t)	3.468	17.69	223.81	244.97
Biomass extrapolated the Romanian shelf (t)				1436.34

Table 6.6.3.1.2.9 - Assessment of dog fish agglomerations in the period October - November 2012, pelagic trawl survey , Romanian area

Depth range (m)	0 - 30m	30 – 50m	50-70 m	Total
Investigated area (Nm^2)	754.58	1294.12	807	2855.7
Variation of the catches (t/ Nm^2)	0.30-1.35	0.00-1.60	0.00-0.86	0.00-1.60
Average catch (t/ Nm^2)	0.736	0.372	0.161	
Biomass of the fishing agglomerations (t)	754.85	482.324	130.53.4	1169.086
Biomass extrapolated the Romanian shelf (t)				1515.883

6.6.3.1.3*Trends in abundance at length or age*

Table 6.6.3.1.3.1 Indices of abundance at length of the piked dogfish over the Romanian littoral

Year	Biomass (t)		Indice of abundance in number of individuals per length classes									
			2008		2009		2010		2011		2012	
2008	883											
2009	2509											
2010	13051											
2011	1690											
2012	1436											
Year	**Abundance (No.ind.)**	class (cm)	%	Abundance (thousands)	%	Abundance (thousands)	%	Abundance (thousands)	%	Abundance (thousands)	%	Abundance (thousands)
2008	126068	89.5					1.00	17.621				
2009	393840	92.5					0.00	0				
2010	1748855	95.5					2.00	35.241				
2011	266064	98.5					2.99	52.862				
2012	226651	101.5					0.00	0	6.78	18.038	0.93	2.955
		104.5	2.28	2.868	1.93	7.601	0.50	8.810	8.48	22.548	0.0	0.0
		107.5	1.51	1.904	8.21	32.334	7.98	140.966	16.95	45.096	2.78	7.540
		110.5	6.82	8.595	14.98	58.997	16.46	290.742	28.81	76.663	10.19	26.583
		113.5	17.42	21.961	19.81	78.020	23.44	414.087	25.42	67.643	34.26	80.033
		116.5	28.04	35.343	27.05	106.534	17.71	312.768	8.48	22.548	27.78	61.020
		119.5	16.67	21.014	16.43	64.708	9.73	171.802	3.39	9.019	8.33	17.464
		122.5	14.39	18.140	7.24	28.514	4.49	79.293	0.00	0	14.81	29.453
		125.5	6.82	8.598	1.93	7.601	2.99	52.862	1.70	4.510	0.93	1.602
		128.5	2.27	2.867	0	0	8.73	154.181				
		131.5	2.27	2.862	1.45	5.711	2.00	35.241				
		134.5	1.52	1.916								
		137.5			0.97	3.820						
		Total	**100**	**126.068**	**100.0**	**393.840**	**100.0**	**1748.855**	**100.0**	**266.064**	**100.0**	**226651**

Table 6.6.3.1.3.2The biomassat length of the piked dogfish over the Romanian littoral.

BIOMASS (t)										
	2008		2009		2010		2011		2012	
class (cm)	**%**	**Biomass (t)**	**%**	**Biomass (t)**	**%**	**Biomass (t)**	**%**	**Biomass (t)**	**%**	**Biomass (t)**
89.5					0.41	52.86				
92.5					0.00	0.00				
95.5					0.91	118.50				
98.5					1.54	201.36				
101.5					0.00	0.00	6.48	109.833851	0.93	13.296296
104.5	0.93	8.24	1.27	31.86	0.30	38.59	7.65	129.816526	0.0	0.0
107.5	1.03	9.09	6.74	169.08	5.32	693.93	15.37	260.719579	2.78	39.888889
110.5	5.11	45.16	13.80	346.17	12.82	1673.05	28.31	480.198320	10.19	146.259259
113.5	15.82	139.71	19.07	478.47	19.98	2607.85	26.83	454.971965	34.26	491.962963
116.5	27.11	239.37	27.13	680.81	16.97	2214.86	9.27	157.145078	27.78	398.888889
119.5	17.32	152.92	17.27	433.30	10.52	1372.70	4.00	67.884406	8.33	119.666667
122.5	16.29	143.83	8.43	211.57	6.18	806.90	0.00	0.000000	14.81	212.740741
125.5	8.03	70.90	2.28	57.19	5.02	655.49	2.09	35.430275	0.93	13.296296
128.5	2.81	24.79	0.00	0.00	15.99	2087.18				
131.5	2.96	26.11	1.90	47.57	4.04	527.74				
134.5	2.59	22.88	0.00	0.00	0.00	0.00				

137.5	0.00	0.00	2.11	52.94	0.00	0.00				
Total	**100.0**	**883.00**	**100.0**	**2508.97**	**100.0**	**13051.00**		**1690.000**	**100.0**	**1436.000**

The population data of picked dogfish at the Romanian Black Sea area are given in the figures bellow – Length frequency data - Figs. 6.6.3.1.3.1 - Fig. 6.6.3.1.3.9 (Maximov et al.,2010a,c; Radu et al., 2010a, Radu 2011,Radu 2012).

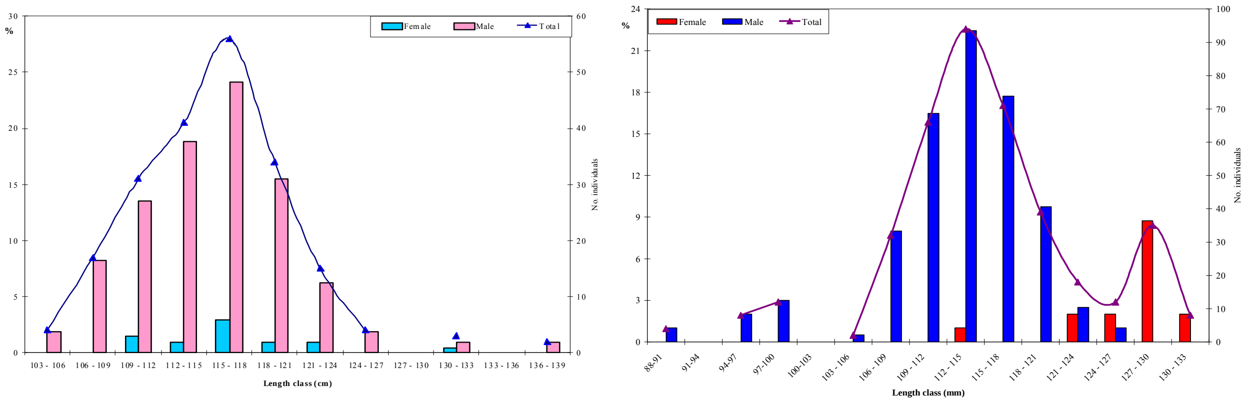


Fig. 6.6.3.1.3.1 Length frequency of piked dogfish in 2009 and in 2010, Romanian Black Sea area.

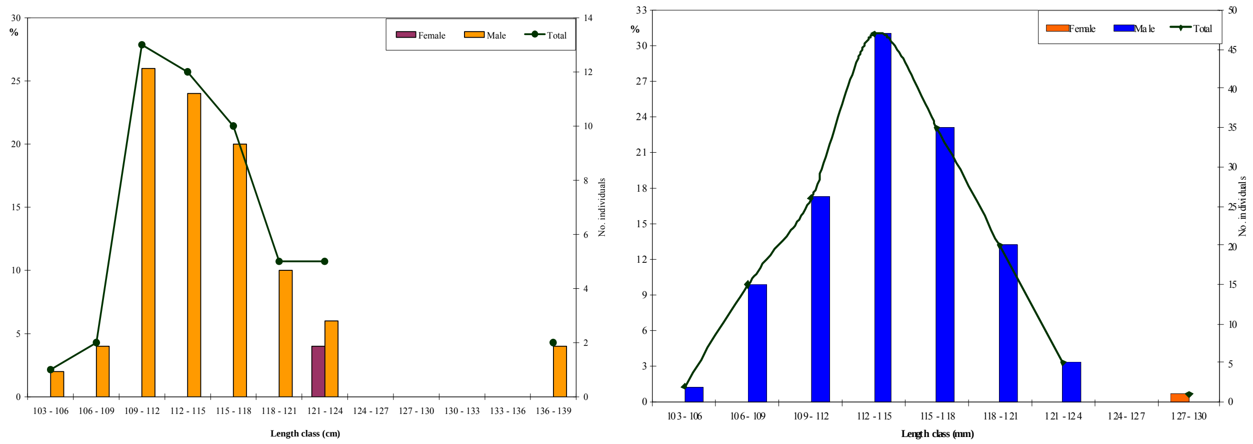


Fig. 6.6.3.1.3.2 Length frequency of piked dogfish in May 2009, in May 2010 at Romanian marine area.

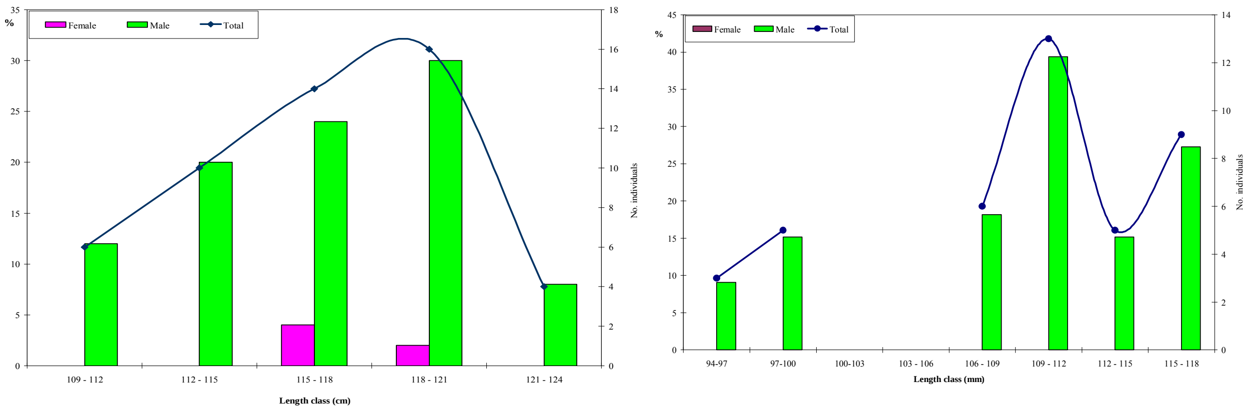


Fig. 6.6.3.1.3.3 Length frequency of piked dogfish in June 2009 and in June 2010 at Romanian marine area.

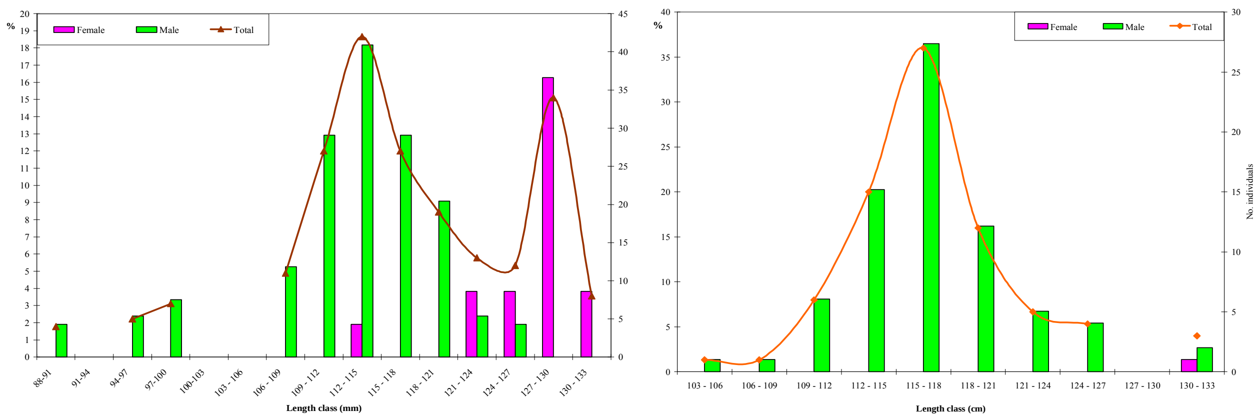


Fig. 6.6.3.1.3.4 Length frequency of piked dogfish in November 2009 and in November 2010.

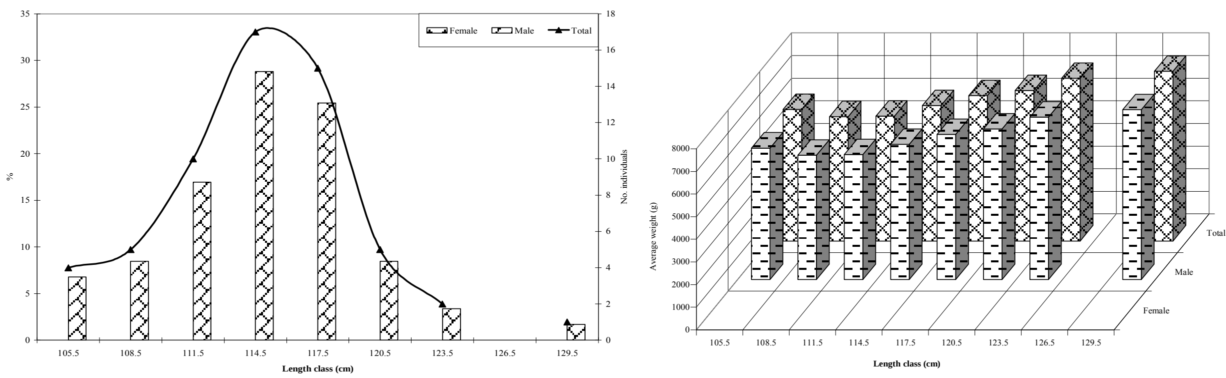
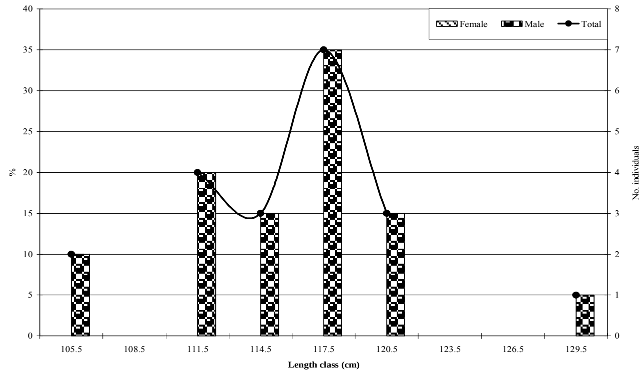


Fig. 6.6.3.1.3.5 Structure on length classes and average weight for dogfish at Romanian marine area in 2011.



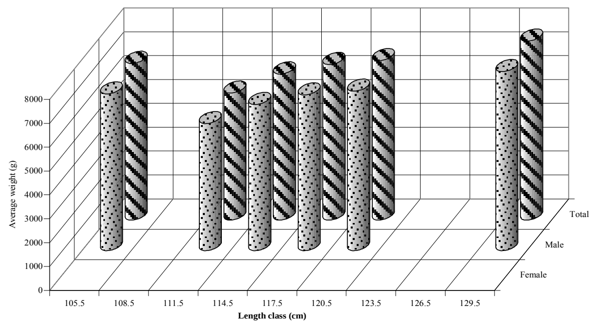
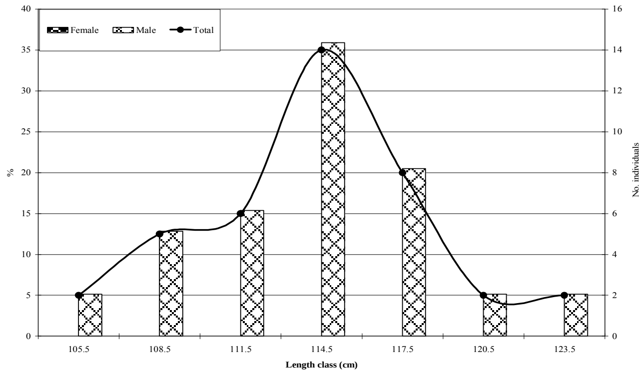


Fig. 6.6.3.1.3.6 Structure on length classes for dogfish at Romanian marine area in 2011, spring period



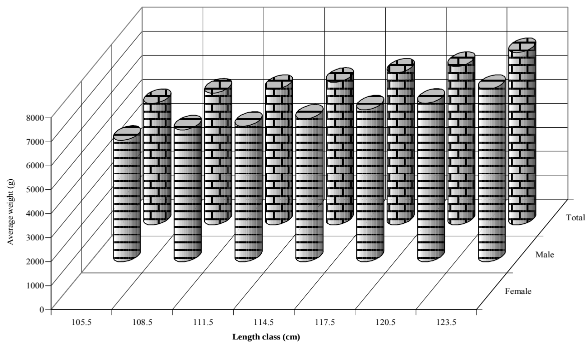


Fig. 6.6.3.1.3.7 Structure on length classes and average weight for dogfish at Romanian marine area in 2011, autumn period.

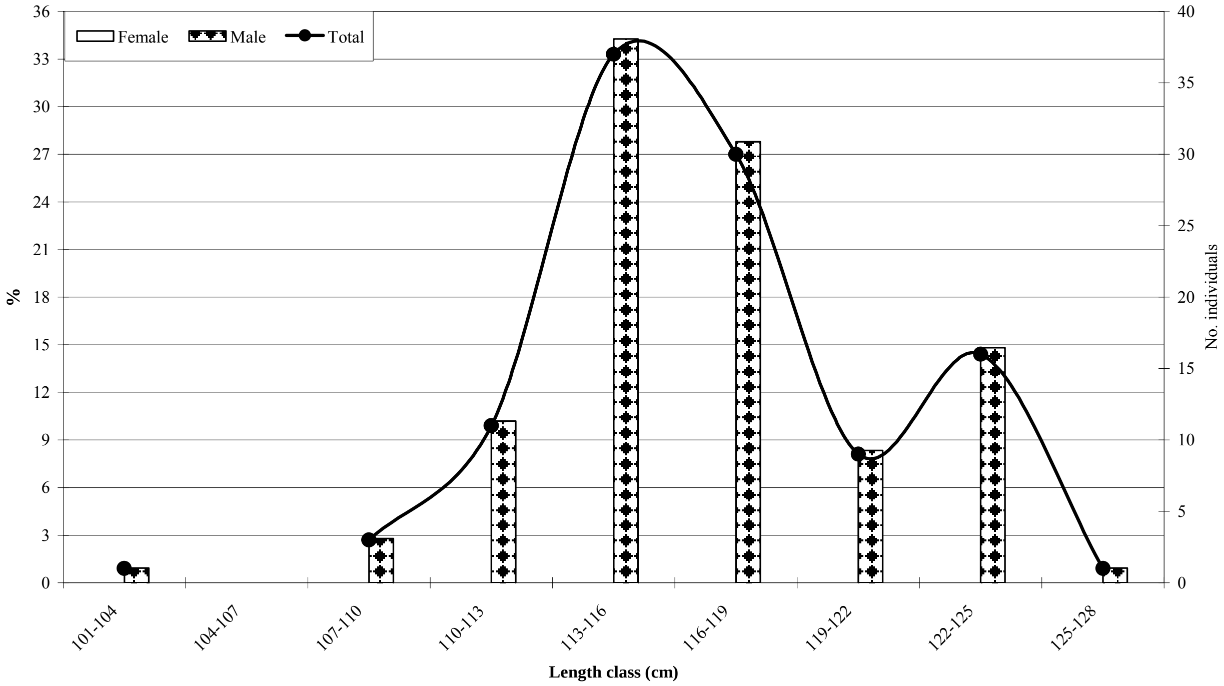


Fig6.6.3.1.3.8: Structure on length classes for dogfish in 2012, total catches

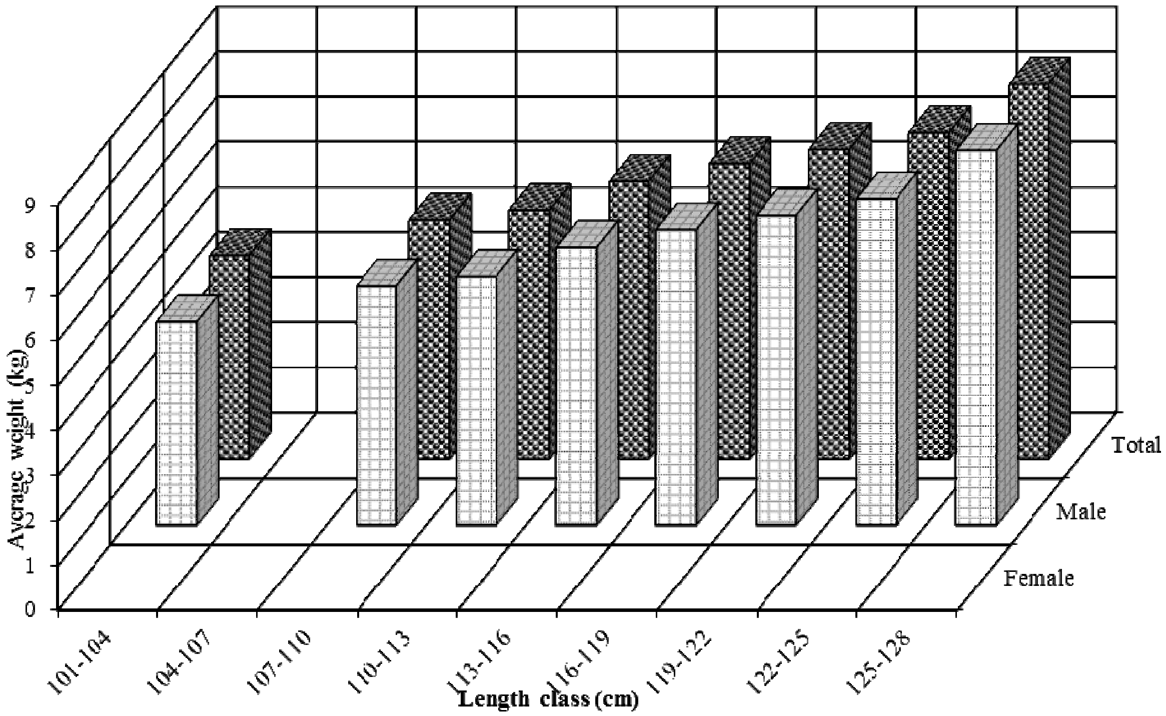


Fig 6.6.3.1.3.9: Mean weight on length classes for dogfish 2012, total catches

Table 6.6.3.1.3.3 Romanian catches in numbers of individuals by length classes.

Year	Catches (t)	Catches in number of individuals and tons per length classes

			2008		2009		2010		2011		2012	
2008	**10.283**											
2009	4.270											
2010	3.069											
2011	3.995											
2012	2.144											
year	**Abundance (no.ind.)**	**class (cm)**	**%**	**Abundance**	**%**	**Abundance**	**%**	**Abundance**	**%**	**Abundance**	**%**	**Abundance**
2008	1468	89.5					1.00	4				
2009	670	92.5					0.00	0				
2010	415	95.5					2.00	8				
2011	655	98.5					2.99	12				
2012	399	101.5					0.00	0			0.93	4
		104.5	2.28	33	1.93	13	0.50	2	6.78	46	0.0	0
		107.5	1.51	22	8.21	55	7.98	33	8.47	61	2.78	11
		110.5	6.82	100	14.98	100	16.46	68	16.95	122	10.19	41
		113.5	17.42	256	19.81	133	23.44	97	28.81	191	34.26	120
		116.5	28.04	412	27.05	181	17.71	74	25.42	157	27.78	91
		119.5	16.67	245	16.43	110	9.73	40	8.47	51	8.33	26
		122.5	14.39	211	7.24	49	4.49	19	3.39	19	14.81	44
		125.5	6.82	100	1.93	13	2.99	12	0.00	0	0.93	2
		128.5	2.27	33	0	0	8.73	36	1.69	9		
		131.5	2.27	33	1.45	10	2.00	8				
		134.5	1.52	22	0	0	0.00	0				
		137.5	0	0	0.97	7	0.00	0				
		Total	**100.0**	**1468**	**100.0**	**670**	**100.0**	**415**	**100.0**	**655**	**100.0**	**339**

6.6.3.1.4*Trends in growth*

No data available or analyses undertaken.

6.6.3.1.5*Trends in maturity*

In Romanian waters the overall sex ratio of males was significantly positive with a rate of 84.29% compared to only 15.61 % females.In Bulgarian waters, the majority of the piked dogfish were females.

6.6.4 *Assessment of historic parameters*

6.6.4.1 Method 1: VIT

6.6.4.1.1*Justification*

EWG 13-12 used the VIT program for estimation of abundance and fishing mortality and YPR-LEN (NOAA Fisheries Toolbox Version 3.1) for obtaining the reference points for dogfish in the Black Sea.

The program VIT is conceived for the analysis of fisheries where the available information is limited. VIT is designed for the analysis of marine populations, exploited by one or several gears, based on single species' catch data (structured by age or size). The main assumption underlying the model is that of steady state, because the program works with pseudo-cohorts and it is therefore not suitable for historical data series.

The program uses the catch data and ancillary parameters for rebuilding the population of the species and the mortality vectors affecting it by means of Virtual Population Analysis (VPA).

Once the virtual population has been rebuilt, an analysis of the fishery can be carried out with the aid of several tools: Comprehensive VPA results, Yield-per-Recruit analysis based on the fishing mortality vector, analysis of sensitivity to parameter values and transition analysis. The latter permits non-equilibrium analysis of how a shift in exploitation regime is reflected in the fisheries. All these tools can be applied to specific studies of competition among fishing gears.

6.6.4.1.2*Input data available*

Given the practice of previous studies, the picked dogfish can be assessed using age-structured methods (Prodanov et al. 1997, Shlyakhov, 1997, Daskalov 1998). Fisheries, biological (age and individual size and growth), trawl survey data and commercial CPUE from all countries need to be thoroughly compiled (Table 6.6.4.2.1).

At the first stage data must be carefully screened and organized into age structured matrices.

Table 6.6.4.2.1 Ukrainian dogfish age/length key (1996-1997).

1996					A/SL key								
	81-85	86-90	91-95	96-100	101-105	106-110	111-115	116-120	121-125	126-130	131-135	136-140	
6	0.036	0.01	0.009										
7	0.131	0.07	0.044										
8	0.298	0.18	0.132	0.0402	0.034	0.01							
9	0.274	0.26	0.228	0.1609	0.092	0.043		0.011					
10	0.143	0.33	0.237	0.2414	0.169	0.086	0.053	0.033					
11	0.119	0.09	0.184	0.2586	0.179	0.187	0.152	0.065	0.013	0.03704			
12		0.02	0.123	0.1897	0.217	0.211	0.181	0.054	0.038	0.04938			
13		0.01	0.044	0.0977	0.217	0.201	0.158	0.087	0.114	0.07407			
14		0.01		0.0115	0.092	0.177	0.24	0.185	0.228	0.08642			
15						0.072	0.181	0.413	0.165	0.23457			
16						0.014	0.035	0.109	0.278	0.22222	0.1111	0.25	
17								0.043	0.139	0.20988	0.2778	0.375	
18									0.025	0.08642	0.3889	0.125	0.25
19											0.1667	0.125	0.375
20											0.0556	0.125	0.125
21												0.166667	0.125
22												0.055556	0.125

1997					A/SL key								
	81-85	86-90	91-95	96-100	101-105	106-110	111-115	116-120	121-125	126-130	131-135	136-140	
6	0.0357	0.0115	0.0088										
7	0.131	0.069	0.0439										
8	0.2976	0.1839	0.1316	0.0402	0.0338	0.0096							
9	0.2738	0.2644	0.2281	0.1609	0.0918	0.0431		0.011					
10	0.1429	0.3333	0.2368	0.2414	0.1691	0.0861	0.0526	0.033					

11	0.119	0.092	0.1842	0.2586	0.1787	0.1866	0.152	0.065	0.013	0.037			
12		0.023	0.1228	0.1897	0.2174	0.2105	0.1813	0.054	0.038	0.0494			
13		0.0115	0.0439	0.0977	0.2174	0.201	0.1579	0.087	0.114	0.0741			
14		0.0115		0.0115	0.0918	0.177	0.2398	0.185	0.228	0.0864			
15						0.0718	0.1813	0.413	0.165	0.2346			
16						0.0144	0.0351	0.109	0.278	0.2222	0.1111	0.25	
17								0.043	0.139	0.2099	0.2778	0.375	
18									0.025	0.0864	0.3889	0.125	0.25
19											0.1667	0.125	0.375
20											0.0556	0.125	0.125
21												0.1667	0.125
22												0.0556	0.125

Table 6.6.4.2.2 Romaniandogfish age/length key

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length class (cm)	21-30	31-35	36-40	41-50	51-55	56-60	61-65	66-70	71-80	81-85	86-90	91-100	101-105	106-110	111-115	116-120	121-125	126-130	131-135	136-140	141-145

6.6.4.1.3*Results*

The VIT software was applied to assess population parameters based on pseudocohort analyses for the 1989-2012 data. In analyse have been used three groups of years: 1989, 1990, 1991; 2001, 2002, 2003 and 2010, 2011, 2012. For these years were run two scenarios using Fterminal = 0.5 and Fterminal = 0.15. The two scenarios were run with M=0.15, and, M = 0.2. The presented results are with M = 0.15. and Fterminal =0.15

Table 6.6.4.3.1- Main parameters used in assessment

Linf= 157	a= 0.0169769
k= 0.153	b= 2.696436
t0= -1.13684	M= 0.15

For Fterminal = 0.5, the results are the following presented in the table 6.6.4.3.2

Table 6.6.4.3.2 – Total F obtained using Fterminal =0.5

Years used in assessment	Total F	Bg	Ge	Ro	Ru	Tk	Uk
1989	0.277	0	0.001	0	0	0.259	0.018
1990	0.277	0	0.002	0	0.003	0.106	0.167
1991	0.277	0	0	0	0	0.241	0.036
2001	0.282	0.008	0.001	0	0.001	0.258	0.014

2002	0.347	0.028	0.012	0	0.001	0.279	0.026
2003	0.370	0.014	0.009	0	0.005	0.183	0.16
2010	0.278	0.173	0	0.001	0.007	0.025	0.072
2011	0.277	0.129	0	0.001	0.001	0.063	0.083
2012	0.344	0.117	0.001	0.001	0.005	0.195	0.025

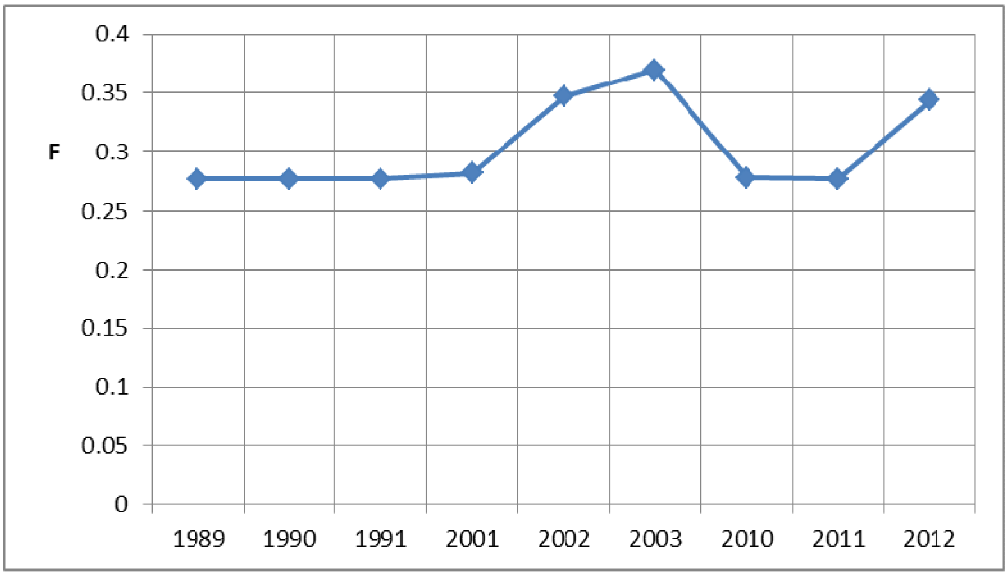


Fig. 6.6.4.3.1 Total F in the case of using the Fterminal = 0.5

Table 6.6.4.3.3 - The biomasses obtained using Fterminal =0.5

Year	1989	1990	1991	2001	2002	2003	2010	2011	2012
Mean biomass (kg)	6304800095.48	1857414441.97	2786875948.00	712688989.40	383858170.00	151897288.60	50473168.00	52200571.00	42477497
SSB (kg)	6304800095.48	1857414441.97	2786875948.00	712688989.40	322328546.70	151897288.60	50473168.00	52200571.00	42477497
Recruitment biomass (kg)	953922314.34	281026915.60	421657303.50	107805121.30	32524541.38	33812017.94	7637430.00	7898374.00	6296022
Growth biomass (kg)	550529775.96	162192667.19	243350126.30	62355718.60	56642985.09	8674145.15	4407944.00	4558087.00	3750589
Natural death biomas (kg)	945720014.32	278612166.30	418031392.20	106903348.40	51844261.05	22784593.29	7570975.00	7830086.00	6371625

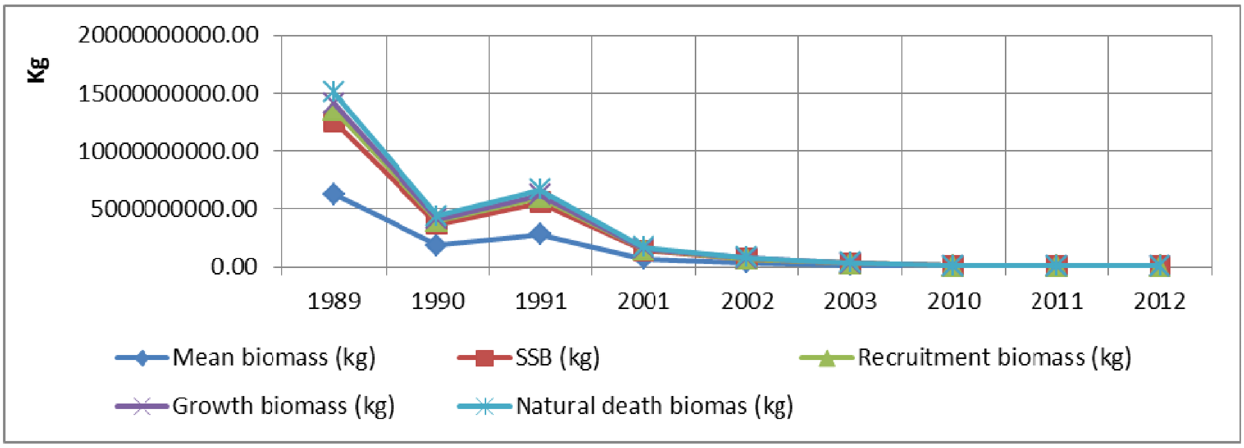


Fig. 6.6.4.3.2 The biomasses obtained using Fterminal = 0.5

Table 6.6.4.3.4 Total F obtained using Fterminal = 0.15

	Total F	Bg	Ge	Ro	Ru	Tk	Uk
2001	0.180	0.007	0	0	0	0.164	0.009
2002	0.249	0.02	0.008	0	0.001	0.201	0.019
2003	0.238	0.009	0.006	0	0.003	0.118	0.103
2010	0.177	0.11	0	0.001	0.005	0.016	0.046
2011	0.176	0.082	0	0.001	0.001	0.04	0.053
2012	0.239	0.103	0	0.001	0.003	0.117	0.015

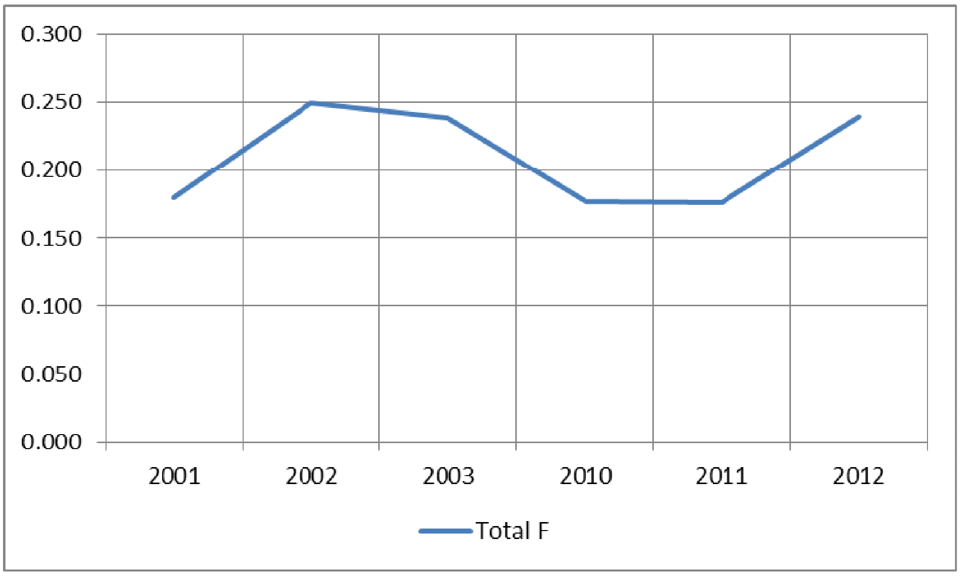


Fig. 6.6.4.3.Total F in the case of using the Fterminal = 0.15

Table- 6.6.4.3.5 The biomasses obtained using Fterminal =0.15

	2001	**2002**	**2003**	**2010**	**2011**	**2012**
Mean biomass (kg)	789668568	397286126.1	168847423.2	56201852	58172429	44522958
SSB (kg)	789668568	397286126.1	168847423.2	56201852	58172429	44522958
Recruitment biomass (kg)	116340957	33323505.33	36393208.91	8272674	8560596	6522407
Growth biomass (kg)	65391347.1	57731304.41	8643811.89	4633754	4793457	3832396
Natural death biomas (kg)	118450285	53717561.99	25327113.48	8430278	8725864	6678444

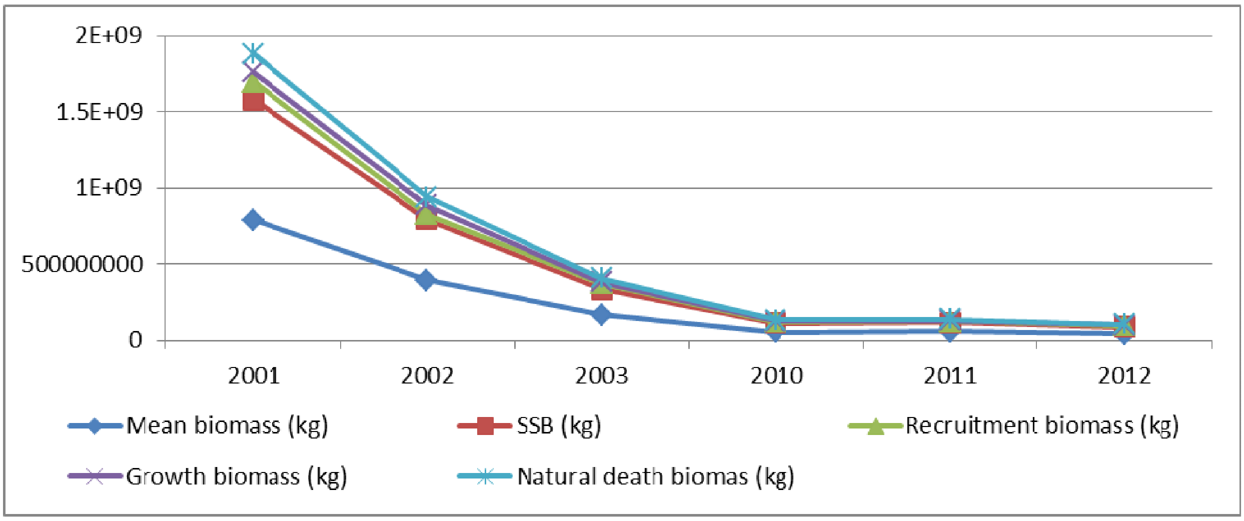


Fig. 6.6.4.3.4 The biomasses obtained using Fterminal = 0.15

Comparing the obtained results in a period of 24 years the stock biomass has decreased dramatically. Only in the last12 years the biomass decreased about 20 times.

Table 6.6.4.3.6Results for 2012 data using Fterminal =0.5

---	Total	Bg	Ge	Ro	Ru	Tk	Uk	
Catch mean age	14.594	15.079	13.972	15.082	13.969	13.973	13.966	
Catch mean length	142.157	143.752	140.133	143.759	140.099	140.114	140.095	
Mean F	0.344	0.117	0.001	0.001	0.005	0.195	0.025	
Global F	0.066	0.037	0	0	0.001	0.025	0.003	
Total catch	3674986	2110142	4838.9	11783.72	34293.44	1340228	173699.1	
Catch/D%	36.58	21	0.05	0.12	0.34	13.34	1.73	
Catch/B%	8.65	4.97	0.01	0.03	0.08	3.16	0.41	
B/R	SSB/R	Y/R	Y/R Bg	Y/R Ge	Y/R Ro	Y/R Ru	Y/R Tk	Y/R Uk
38224.591	38224.59	3307.041	1898.872	4.354	10.604	30.86	1206.043	156.308
Current Stock Mean Age	10.305							
Current Stock Critical Age	7							
Virgin Stock Critical Age	8							
Current Stock Mean Length	127.979							
Current Stock Critical Length	111.79							
Virgin Stock Critical Length	118.204							
Number of recruits, R	1111.26							
Mean Biomass, Bmean	42477497							
Spawning Stock Biomass, SSB	42477497							
Biomass Balance, D	10046610							
Natural death/D	63.42							
Bmax/Bmean	14.82							
Turnover, D/Bmean	23.65							
Class	Lower Age	Mean Age	Lower Length	Mean Length	Lower Weight	Mean Weight	Maturity ratio	
1	7	7.487	111.79	114.998	5665.655	6118.429	1	
2	8	8.487	118.204	120.956	6585.389	7009.664	1	
3	9	9.487	123.708	126.069	7445.221	7836.599	1	
4	10	10.486	128.431	130.453	8236.735	8592.525	1	
5	11	11.485	132.484	134.215	8956.532	9276.763	1	
6	12	12.484	135.962	137.446	9604.75	9890.938	1	

7	13	13.482	138.947	140.214	10183.91	10436.85	1	
8	14	14.455	141.508	142.536	10698.02	10909.26	1	
9	15	15.434	143.706	144.548	11151.97	11329.39	1	
10	16	16.406	145.592	146.269	11551.03	11696.65	1	
11	17	17.414	147.211	147.803	11900.54	12030.25	1	
12	18	18.419	148.599	149.113	12205.71	12319.98	1	
13	19	19.446	149.791	150.26	12471.47	12577.22	1	
+	20	---	150.814	---	12702.4	---		
Catch in Numbers								
Class	Total catch	Catch ofBg	Catch of Ge	Catch of Ro	Catch of Ru	Catch of Tk	Catch of Uk	
1	0.97	0	0	0	0.02	0.83	0.11	
2	4.01	0	0.01	0	0.09	3.46	0.45	
3	4.42	0	0.01	0	0.1	3.81	0.5	
4	12.12	0	0.04	0	0.27	10.46	1.36	
5	16.7	0	0.05	0	0.37	14.41	1.87	
6	16.42	1.77	0.05	0.01	0.32	12.64	1.63	
7	25.12	5.26	0.06	0.03	0.44	17.11	2.22	
8	100.34	83.97	0.05	0.47	0.35	13.72	1.78	
9	85.78	68.22	0.05	0.38	0.38	14.83	1.92	
10	51.07	28	0.07	0.16	0.5	19.78	2.56	
11	15.03	1.77	0.04	0.01	0.29	11.43	1.48	
12	5.02	0	0.01	0	0.11	4.33	0.56	
13	1.28	0	0	0	0.03	1.11	0.14	
Total	338.29	188.99	0.46	1.06	3.27	127.93	16.59	
Mean Age	14.594	15.079	13.972	15.082	13.969	13.973	13.966	
Mean Length	142.157	143.752	140.133	143.759	140.099	140.114	140.095	
Catch in Weight								
Class	Total catch	Catch ofBg	Catch ofGe	Catch of Ro	Catch of Ru	Catch of Tk	Catch of Uk	
1	5921.6	0	12.73	0	135.58	5086.62	686.67	
2	28137.07	0	87.48	0	621.34	24281.48	3146.78	
3	34665.04	0	114.1	0	781.47	29860.58	3908.9	
4	104174.7	0	321.7	0	2284.92	89888.81	11679.22	
5	154958.3	0	482.39	0	3443.35	133680.4	17352.19	
6	162432.2	17493.31	452.61	93.47	3178.16	125057.1	16157.54	
7	262215.1	54936.95	651.26	295.88	4567.79	178597	23166.25	
8	1094595	916021.7	544.59	5120.26	3807.55	149647.	19453.5	

						2	1	
9	971857.5	772870.5	612.69	4318.2	4330.77	167968.6	21756.73	
10	597362.9	327542.9	827.19	1842.22	5896.75	231353.1	29900.72	
11	180795.6	21276.93	500.46	113.69	3532.32	137520.2	17852.04	
12	61803.32	0	179.38	0	1365.05	53345.53	6913.36	
13	16067.52	0	52.32	0	348.39	13941.6	1725.22	
Total	3674986	2110142	4838.9	11783.72	34293.44	1340228	173699.1	
Percentage	---	57.42	0.13	0.32	0.93	36.47	4.73	
VPA Results--Numbers								
Class	Initial number	Mean number						
1	1111.26	1031.46						
2	955.57	885.4						
3	818.75	758.14						
4	700.6	644.66						
5	591.78	541.35						
6	493.87	450.57						
7	409.87	368.23						
8	329.51	254.03						
9	191.07	131.34						
10	85.58	50.71						
11	26.91	16.63						
12	9.38	5.95						
13	3.47	2.56						
Total	---	5141.04						
Stock Mean Age	---	10.305						
Stock Mean Length	---	127.979						
VPA Results--Weight								
Class	Initial Weight	Mean Weight						
1	6296022	6310915						
2	6292827	6206362						
3	6095775	5941269						
4	5770697	5539284						
5	5300311	5022007						
6	4743543	4456526						
7	4174051	3843140						
8	3525097	2771305						
9	2130786	1488019						
10	988593.2	593139.1						
11	320208	200118.2						
12	114531.2	73276.55						

13	43335.01	32135.05						
Total	---	42477497						
SSB	---	42477497						
VPA Results--Mortalities								
Class	Z	Total F	F of Bg	F of Ge	F of Ro	F of Ru	F of Tk	F of Uk
1	0.151	0.001	0	0	0	0	0.001	0
2	0.155	0.005	0	0	0	0	0.004	0.001
3	0.156	0.006	0	0	0	0	0.005	0.001
4	0.169	0.019	0	0	0	0	0.016	0.002
5	0.181	0.031	0	0	0	0.001	0.027	0.003
6	0.186	0.036	0.004	0	0	0.001	0.028	0.004
7	0.218	0.068	0.014	0	0	0.001	0.046	0.006
8	0.545	0.395	0.331	0	0.002	0.001	0.054	0.007
9	0.803	0.653	0.519	0	0.003	0.003	0.113	0.015
10	1.157	1.007	0.552	0.001	0.003	0.01	0.39	0.05
11	1.053	0.903	0.106	0.003	0.001	0.018	0.687	0.089
12	0.993	0.843	0	0.002	0	0.019	0.728	0.094
13	0.65	0.5	0	0.002	0	0.011	0.434	0.054
Mean Mort. rates	0.494	0.344	0.117	0.001	0.001	0.005	0.195	0.025
Global Fs	---	0.066	0.037	0	0	0.001	0.025	0.003
---	Critical age	Critical length						
Current stock	7	111.79						
Virgin stock	8	118.204						
Total Biomass balance (D): 10046610.15								
---	Biomass	Percentage						
Recruitment	6296022	62.67						
Growth	3750589	37.33						
Natural death	6371625	63.42						
Fishing	3674986	36.58						
R/B(mean)	14.82							
D/B(mean)	23.65							
B(max)/B(mean)	14.82							
B(max)/D	62.67							

Table 6.6.4.3.7Summary results for 2012 data using Fterminal = 0.15

---	Total	Bg	Ge	Ro	Ru	Tk	Uk	
Catch mean age	14.599	15.084	13.979	15.087	13.975	13.979	13.973	
Catch mean length	142.165	143.76	140.143	143.767	140.109	140.123	140.105	
Mean F	0.239	0.103	0	0.001	0.003	0.117	0.015	
Global F	0.063	0.035	0	0	0.001	0.024	0.003	

Total catch	3676359	2110889	4840.83	11787.89	34307.19	1340765	173768.7	
Catch/D%	35.5	20.39	0.05	0.11	0.33	12.95	1.68	
Catch/B%	8.26	4.74	0.01	0.03	0.08	3.01	0.39	
B/R	SSB/R	Y/R	Y/R Bg	Y/R Ge	Y/R Ro	Y/R Ru	Y/R Tk	Y/R Uk
38682.431	38682.43	3194.094	1833.983	4.206	10.242	29.807	1164.884	150.974
Current Stock Mean Age	10.357							
Current Stock Critical Age	7							
Virgin Stock Critical Age	8							
Current Stock Mean Length	128.128							
Current Stock Critical Length	111.79							
Virgin Stock Critical Length	118.204							
Number of recruits, R	1150.99							
Mean Biomass, Bmean	44522958							
Spawning Stock Biomass, SSB	44522958							
Biomass Balance, D	10354803							
Natural death/D	64.5							
Bmax/Bmean	14.65							
Turnover, D/Bmean	23.26							
Class	Lower Age	Mean Age	Lower Length	Mean Length	Lower Weight	Mean Weight	Maturity ratio	
1	7	7.487	111.79	114.998	5666.797	6119.665	1	
2	8	8.487	118.204	120.956	6586.717	7011.09	1	
3	9	9.487	123.708	126.069	7446.724	7838.195	1	
4	10	10.486	128.431	130.453	8238.399	8594.301	1	
5	11	11.485	132.484	134.216	8958.343	9278.699	1	
6	12	12.485	135.962	137.447	9606.693	9893.005	1	
7	13	13.482	138.947	140.214	10185.97	10439.07	1	
8	14	14.456	141.508	142.539	10700.19	10912.19	1	
9	15	15.438	143.706	144.556	11154.23	11333.38	1	
10	16	16.419	145.592	146.29	11553.37	11703.65	1	
11	17	17.438	147.211	147.837	11902.95	12040.13	1	
12	18	18.456	148.599	149.158	12208.18	12332.37	1	
13	19	19.475	149.791	150.29	12474	12586.44	1	
+	20	---	150.814	---	12705	---		
Catch in Numbers								
Class	Total catch	Catch of Bg	Catch ofGe	Catch of Ro	Catch of Ru	Catch ofTk	Catch of Uk	
1	0.97	0	0	0	0.02	0.83	0.11	

2	4.01	0	0.01	0	0.09	3.46	0.45	
3	4.42	0	0.01	0	0.1	3.81	0.5	
4	12.12	0	0.04	0	0.27	10.46	1.36	
5	16.7	0	0.05	0	0.37	14.41	1.87	
6	16.42	1.77	0.05	0.01	0.32	12.64	1.63	
7	25.12	5.26	0.06	0.03	0.44	17.11	2.22	
8	100.34	83.97	0.05	0.47	0.35	13.72	1.78	
9	85.78	68.22	0.05	0.38	0.38	14.83	1.92	
10	51.07	28	0.07	0.16	0.5	19.78	2.56	
11	15.03	1.77	0.04	0.01	0.29	11.43	1.48	
12	5.02	0	0.01	0	0.11	4.33	0.56	
13	1.28	0	0	0	0.03	1.11	0.14	
Total	338.29	188.99	0.46	1.06	3.27	127.93	16.59	
Mean Age	14.599	15.084	13.979	15.087	13.975	13.979	13.973	
Mean Length	142.165	143.76	140.143	143.767	140.109	140.123	140.105	
Catch in Weight								
Class	Total catch	Catch of Bg	Catch of Ge	Catch of Ro	Catch of Ru	Catch of Tk	Catch of Uk	
1	5922.8	0	12.73	0	135.61	5087.64	686.81	
2	28142.8	0	87.5	0	621.46	24286.42	3147.42	
3	34672.1	0	114.12	0	781.62	29866.66	3909.69	
4	104196.2	0	321.77	0	2285.4	89907.39	11681.63	
5	154990.7	0	482.49	0	3444.07	133708.3	17355.81	
6	162466.1	17496.97	452.7	93.49	3178.82	125083.2	16160.92	
7	262271.1	54948.67	651.4	295.95	4568.76	178635.1	23171.19	
8	1094889	916267.8	544.74	5121.64	3808.57	149687.3	19458.73	
9	972199.5	773142.5	612.91	4319.72	4332.3	168027.7	21764.39	
10	597720.5	327739	827.68	1843.32	5900.28	231491.6	29918.62	
11	180944.2	21294.42	500.87	113.78	3535.22	137633.2	17866.71	
12	61865.47	0	179.56	0	1366.43	53399.18	6920.31	
13	16079.3	0	52.36	0	348.64	13951.82	1726.48	
Total	3676359	2110889	4840.83	11787.89	34307.19	1340765	173768.7	
Percentage	---	57.42	0.13	0.32	0.93	36.47	4.73	
VPA Results--Numbers								
Class	Initial number	Mean number						
1	1150.99	1068.35						
2	989.77	917.15						
3	848.18	785.47						

4	725.94	668.19						
5	613.58	561.6						
6	512.64	467.99						
7	426.02	383.23						
8	343.41	267.09						
9	203.01	142.77						
10	95.81	60.83						
11	35.62	25.06						
12	16.83	13.03						
13	9.86	8.52						
Total	---	5369.28						
Stock Mean Age	---	10.357						
Stock Mean Length	---	128.128						
VPA Results--Weight								
Class	Initial Weight	Mean Weight						
1	6522407	6537943						
2	6519310	6430236						
3	6316158	6156686						
4	5980543	5742589						
5	5496690	5210919						
6	4924769	4629861						
7	4339406	4000576						
8	3674546	2914511						
9	2264421	1618024						
10	1106964	711936.8						
11	423950.2	301733						
12	205460.3	160747.6						
13	122968.9	107195.4						
Total	---	44522958						
SSB	---	44522958						
VPA Results--Mortalities								
Class	Z	Total F	F of Bg	F of Ge	F of Ro	F of Ru	F of Tk	F of Uk
1	0.151	0.001	0	0	0	0	0.001	0
2	0.154	0.004	0	0	0	0	0.004	0
3	0.156	0.006	0	0	0	0	0.005	0.001
4	0.168	0.018	0	0	0	0	0.016	0.002
5	0.18	0.03	0	0	0	0.001	0.026	0.003
6	0.185	0.035	0.004	0	0	0.001	0.027	0.003
7	0.216	0.066	0.014	0	0	0.001	0.045	0.006
8	0.526	0.376	0.314	0	0.002	0.001	0.051	0.007

9	0.751	0.601	0.478	0	0.003	0.003	0.104	0.013
10	0.99	0.84	0.46	0.001	0.003	0.008	0.325	0.042
11	0.75	0.6	0.071	0.002	0	0.012	0.456	0.059
12	0.535	0.385	0	0.001	0	0.009	0.332	0.043
13	0.3	0.15	0	0	0	0.003	0.13	0.016
Mean Mort. rates	0.389	0.239	0.103	0	0.001	0.003	0.117	0.015
Global Fs	---	0.063	0.035	0	0	0.001	0.024	0.003
---	Critical age	Critical length						
Current stock	7	111.79						
Virgin stock	8	118.204						
Total Biomass balance (D): 10354802.98								
---	Biomass	Percentage						
Recruitment	6522407	62.99						
Growth	3832396	37.01						
Natural death	6678444	64.5						
Fishing	3676359	35.5						
R/B(mean)	14.65							
D/B(mean)	23.26							
B(max)/B(mean)	14.65							
B(max)/D	62.99							

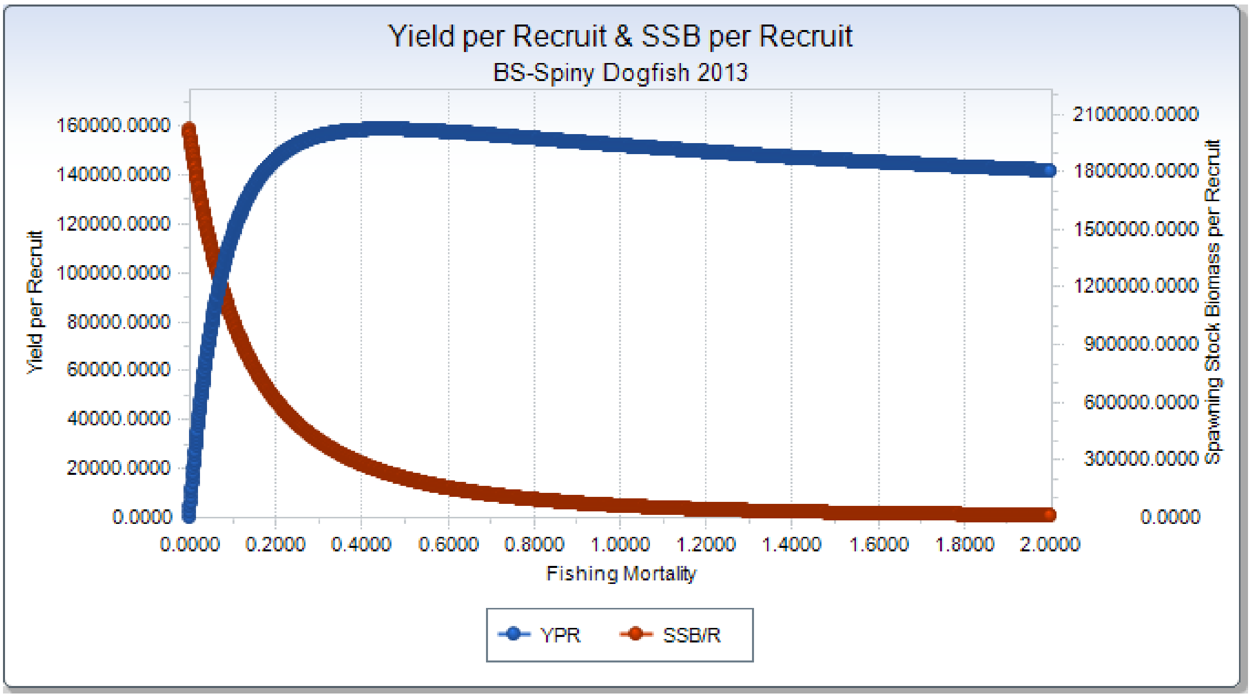
Table 6.6.4.3.8 Reference points for Black Sea Dogfish using YPRLEN for M= 0.2

Reference Point	F	YPR	SSB/R	TSB/R
F-zero	0	0	1280998.23	1789503.586
F0.1	0.2318	116322.7541	389446.278	852462.9104
Fmax	0.7856	134144.6204	76862.70794	461902.1474
Fat 30%MSP	0.235	116759.4491	384485.9842	846939.0299

Table 6.6.4.3.9 Reference points for Black Sea Dogfish using YPRLEN for M= 0.15

Reference Point	F	YPR	SSB/R	TSB/R
F-zero	0	0	2016927.973	2565302.335
F0.1	0.1772	141775.8723	681852.3199	1189739.304
Fmax	0.4538	158447.8695	232975.4451	689373.6313
Fat 30%MSP	0.202	146340.5887	605483.4199	1108217.316

In the following are presented the graphs obtained using M=0.15


Yield per Recruit & SSB per Recruit
BS-Spiny Dogfish 2013
Yield per Recruit
Spawning Stock Biomass per Recruit
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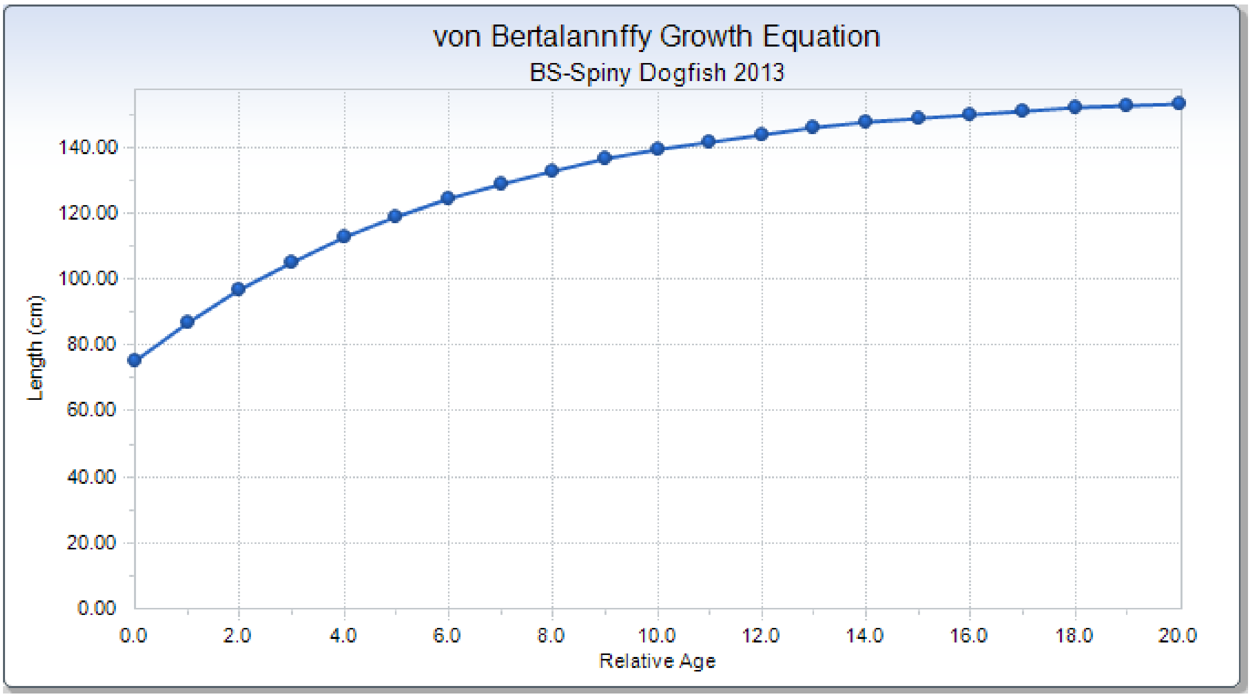
140000.0000
120000.0000
100000.0000
80000.0000
60000.0000
40000.0000
20000.0000
0.0000
2100000.0000
1800000.0000
1500000.0000
1200000.0000
900000.0000
600000.0000
300000.0000
0.0000
0.0000
0.2000
0.4000
0.6000
0.8000
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality
YPR
SSB/R


von Bertalannffy Growth Equation
BS-Spiny Dogfish 2013
Length (cm)
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.0
2.0
4.0
6.0
8.0
10.0
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14.0
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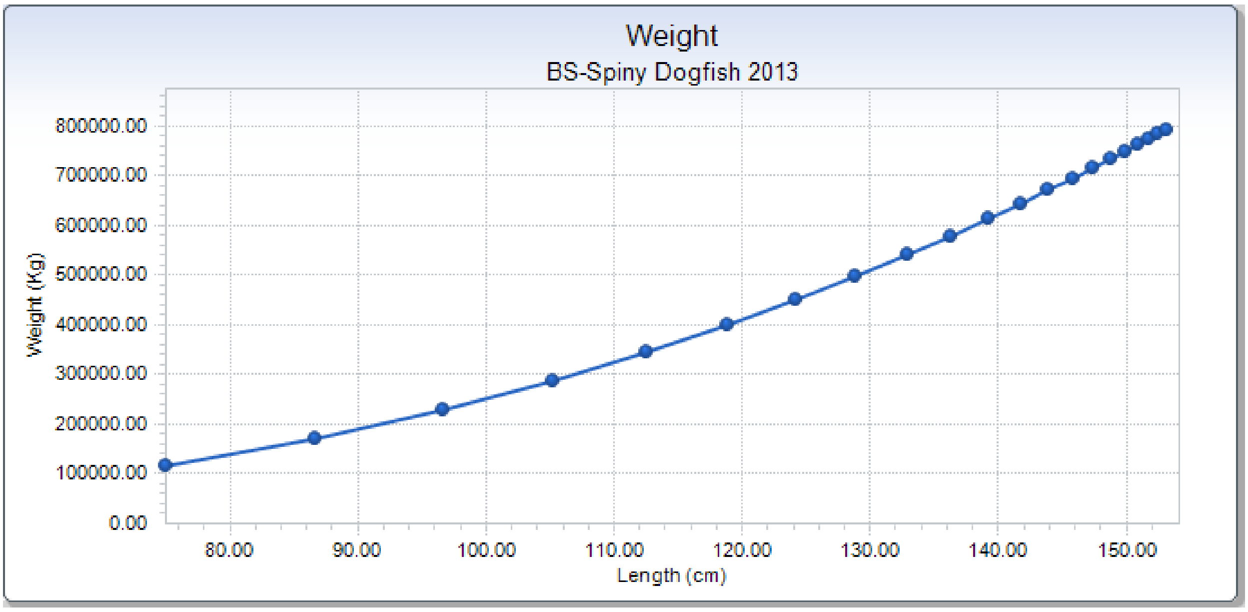
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400000.00
300000.00
200000.00
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80.00
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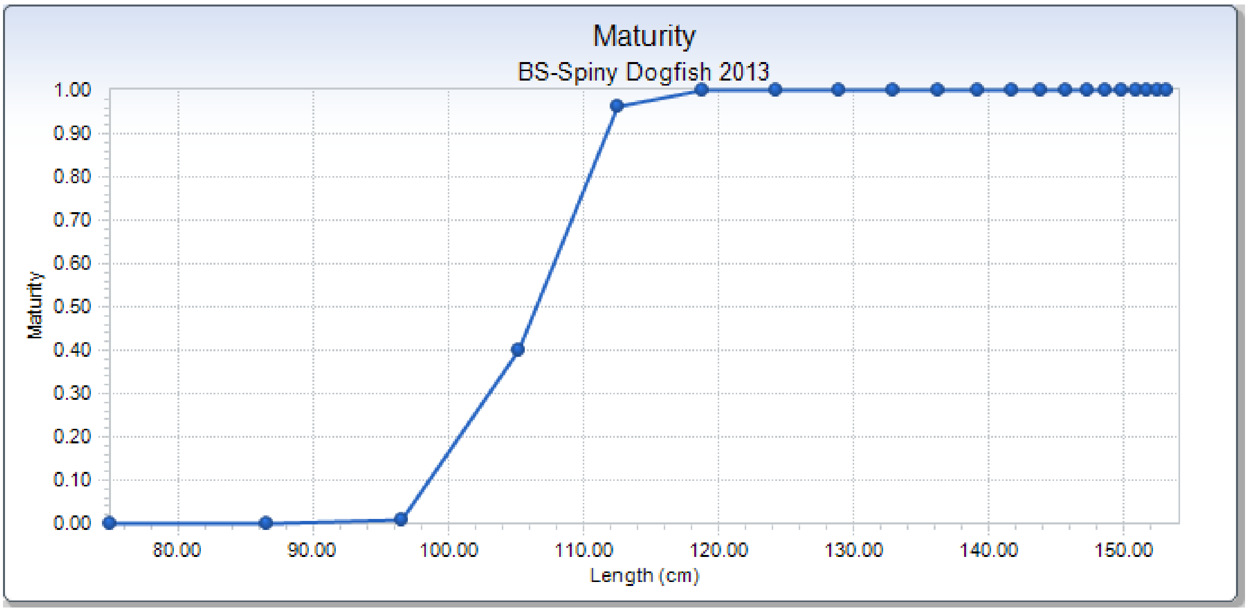
100.00
110.00
120.00
130.00
140.00
150.00
Length (cm)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Maturity
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0.50
0.40
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90.00
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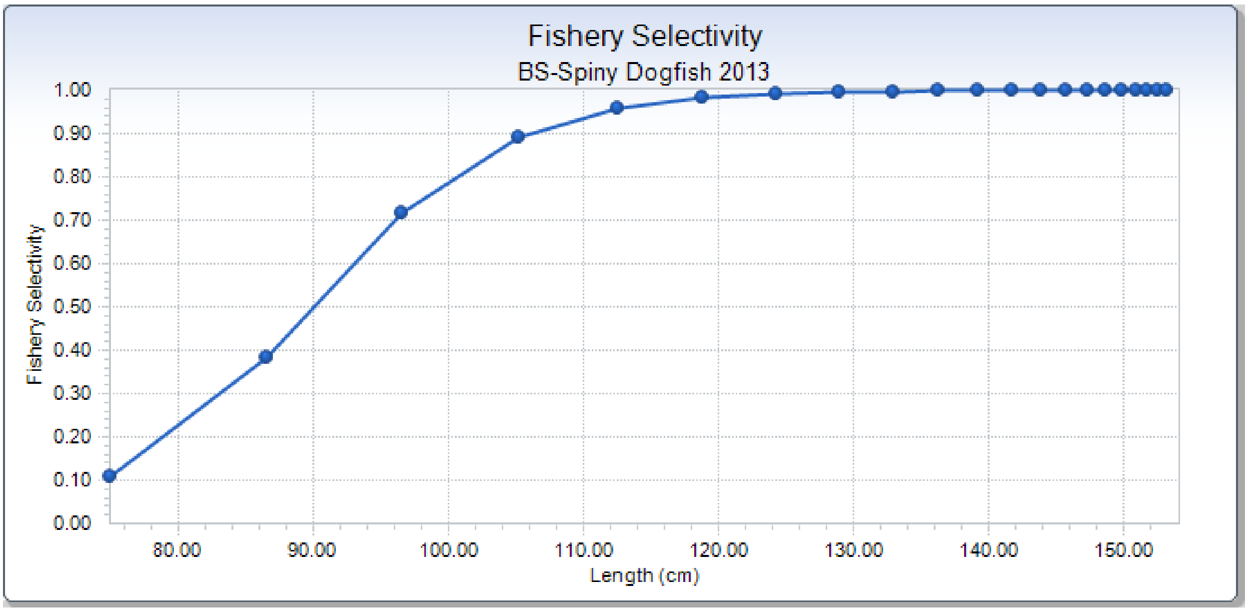
120.00
130.00
140.00
150.00
Length (cm)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BS-Spiny Dogfish 2013
Fishery Selectivity
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0.10
0.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
Length (cm)


Weight
BS-Spiny Dogfish 2013
Weight (Kg)
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700000.00
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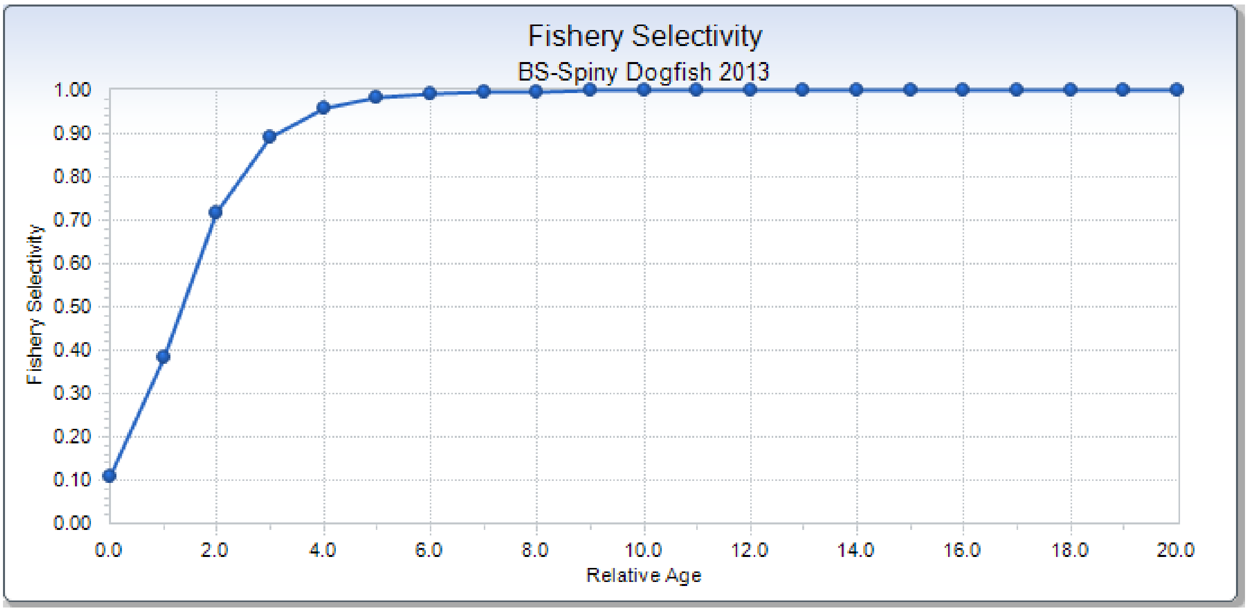
Relative Age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BS-Spiny Dogfish 2013
Fishery Selectivity
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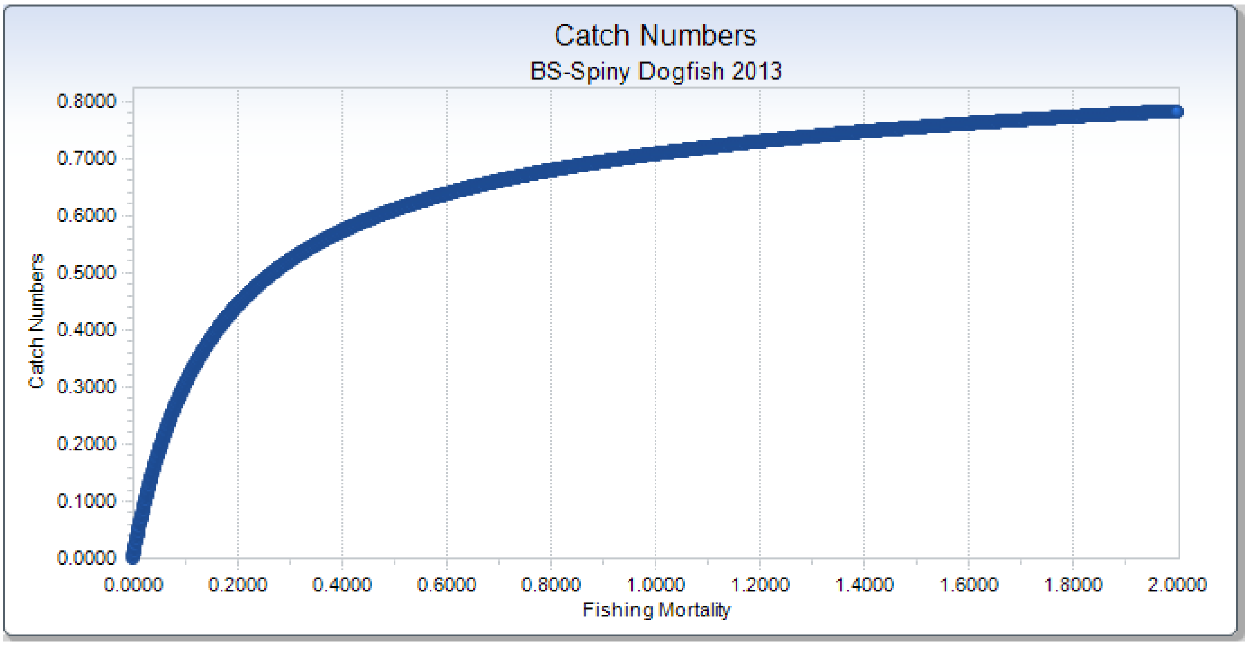
20.0
Relative Age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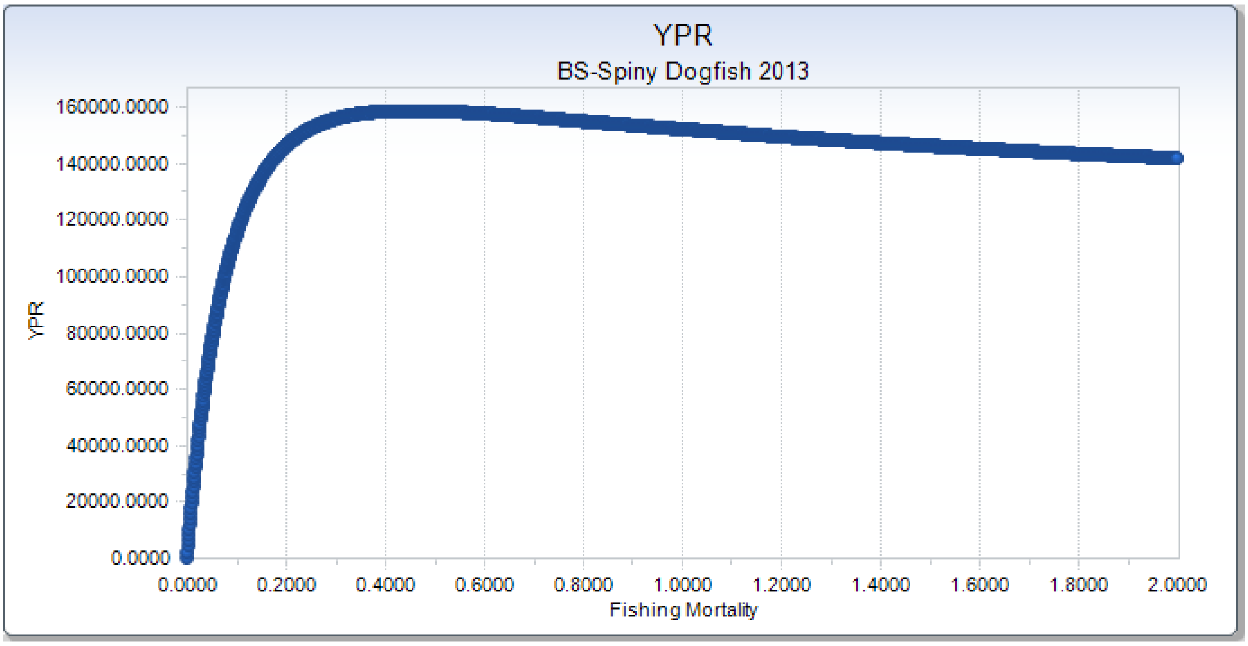
Fishing Mortality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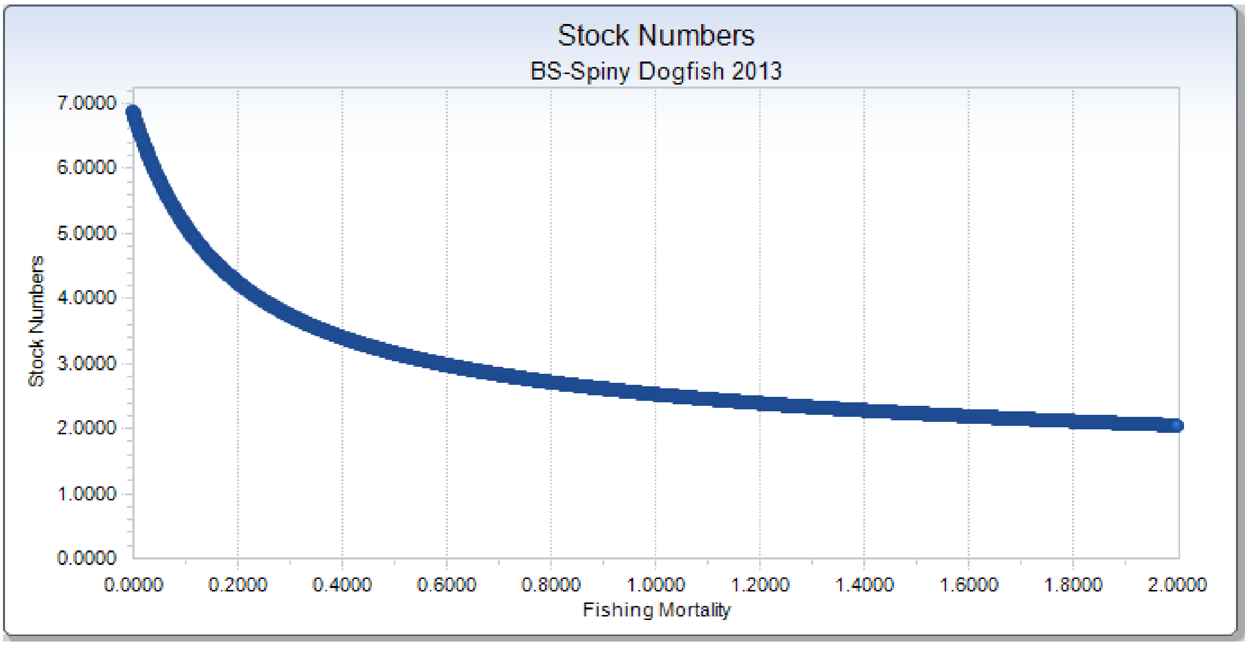
Fishing Mortality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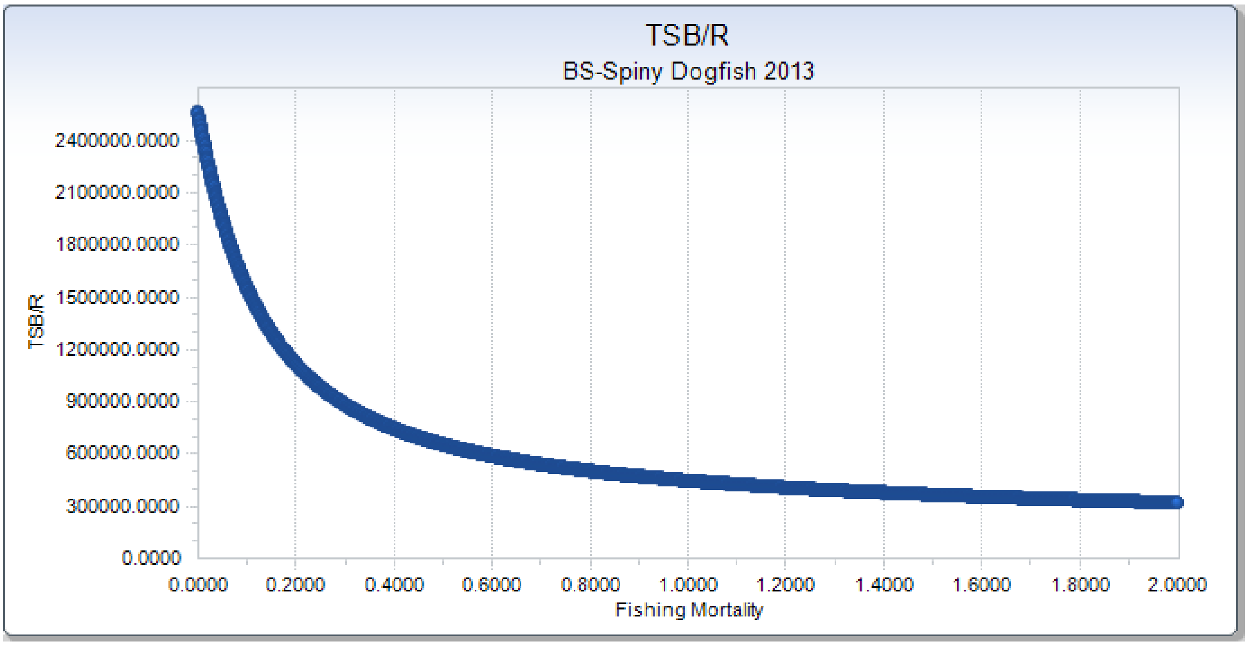
Fishing Mortality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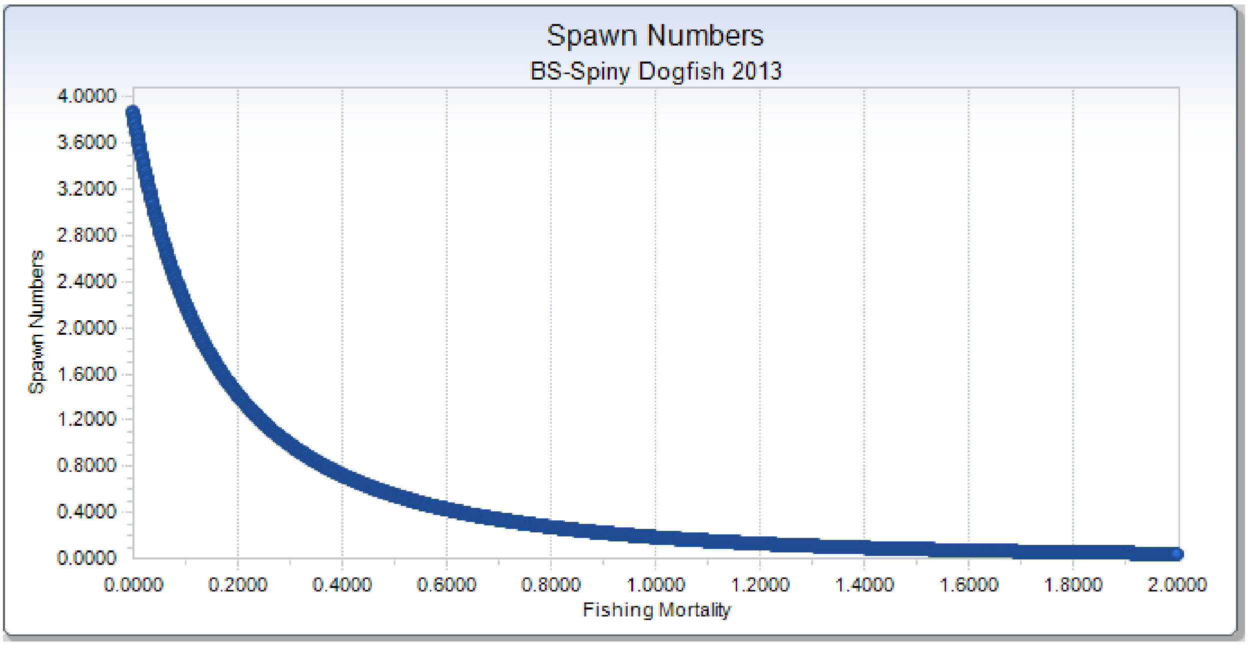
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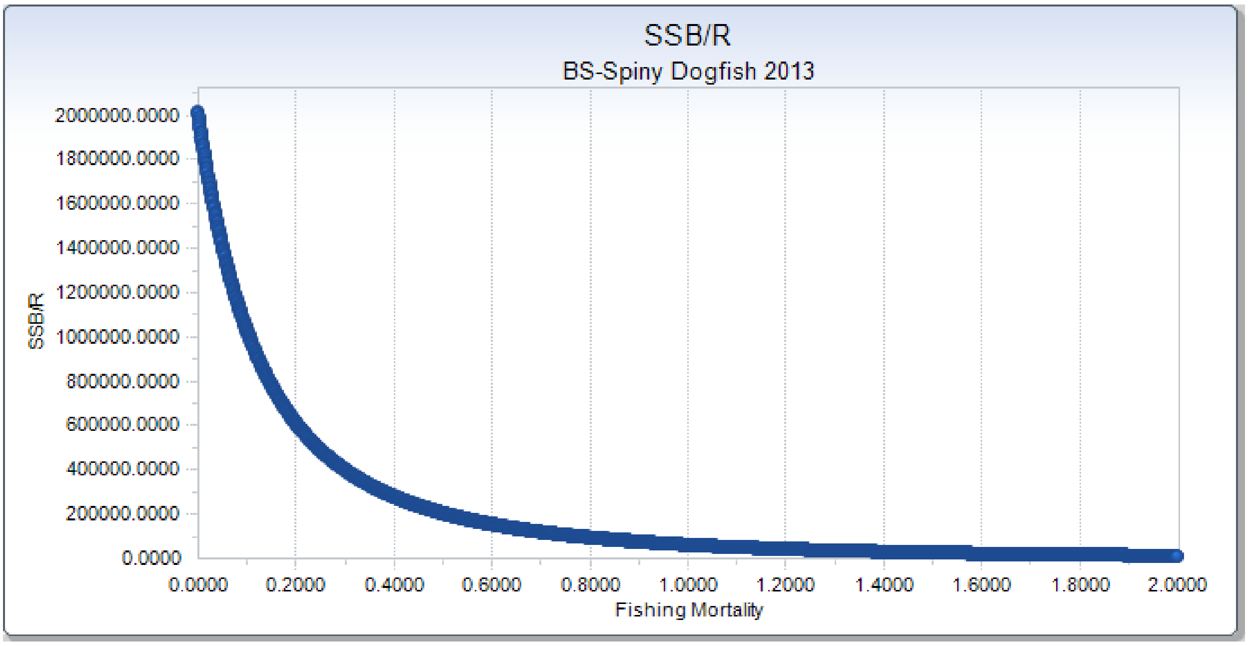
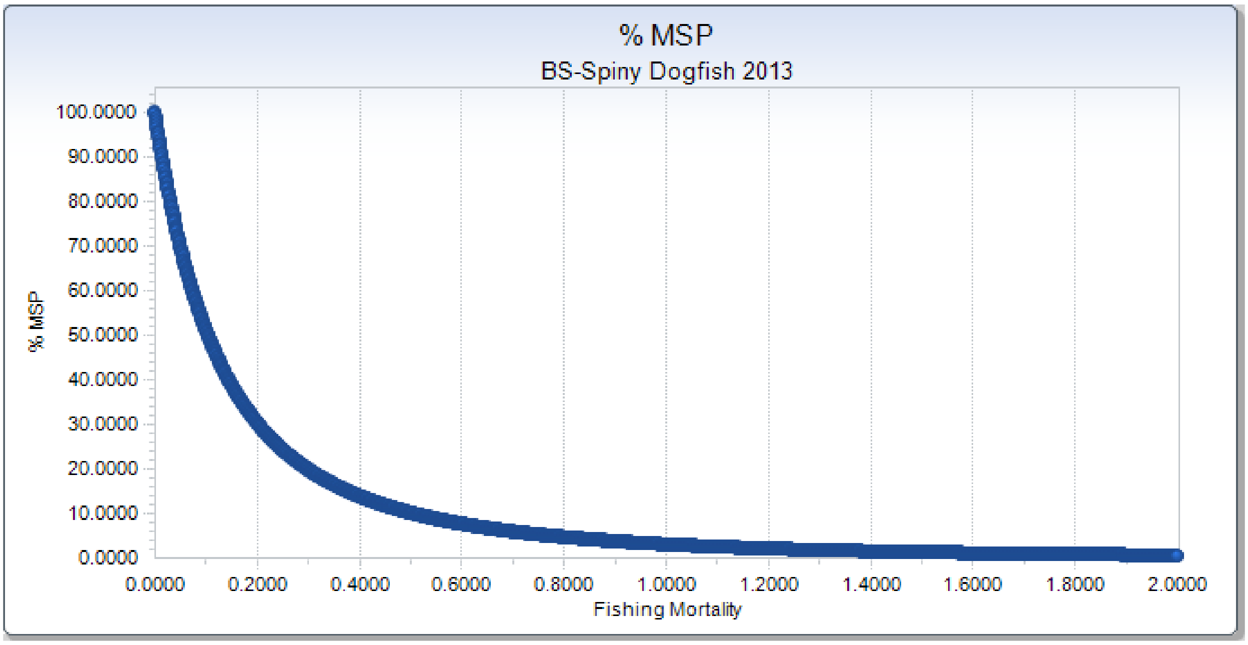
1.0000
1.2000
1.4000
1.6000
1.8000
2.0000
Fishing Mortality





6.6.5 *Short term prediction of stock biomass and catch*

The analyze of data show that the catches and biomasses decreased very much. The current F is almost the same as F0.1 for 2011 (0.177), but increased in 2012 to 0.238.

Historical analysis shows that the state of spiny dogfish stock has been influenced not only by fishing which was at quite high level due to the bigger number of trawlers and high levels of the spiny dogfish by-catch.
The state of the species has also been influenced by ecological changes due to eutrophication and *Mnemiopsis leiydi* invasion and outburst in Black Sea. Comb jelly conquered with small pelagic fish for the food.
Simultaneously, the small pelagic fishes are important trophic base for the dogfish in the Black Sea.

We assume the decrease of the small pelagic stocks due to overexploitation and eutrophication processes which have a strong impact on the top predators including Elasmobranches in the Black Sea (BSC, 2008, Daskalov et all., 2009, 2011; Radu et all., 2011a,b; Shlyahov V. and Daskalov G., 2008).

6.6.6 *Medium term prediction of stock biomass and catch*

Taking into account that the current F = 0.238 the stock is considered to be overexploited.

6.6.7 *Long term predictions*

Continuing to operate in the same manner, in the competitive system without management at the regional level will result in the collapse of the dogfish stock.

6.6.8 *Scientific advice*

The lack of a fishery independent scientific survey to monitor dogfish all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. EWG 13 12 recommends such a survey to be established. Also age reading of dogfish needs to be calibrated between different national laboratories to avoid discrepancy between national catch-at-data.

It is very important the improvement of catch statistics regarding *Squalus acanthias* in the Black Sea area. Catch information is vital for the successful management of this species. Also, thejoint surveys (6 Black Sea countries) are necessary to follow the distribution patterns, spawning areas, CPUE series, biomass estimations, diet, maturity indices etc.

6.6.8.1 Short term considerations

State of the spawning stock size:

The assessment is considered only indicative of relative stock status and trends. The SSB is estimated at 44522 tons in 2012 that seems to be several times bellow the historical high (about 100 000t).

State of recruitment:

The recruitment in 2012is estimated at6522 tons.

State of exploitation:

The STECF EWG 1312estimates $F_{0.1}$= 0.177 (Fmsy proxy)as a limit reference point consistent with high long term yields and low risk of fishery collapse for dogfish in the Black Sea. Taking into account that the current F = 0.238the stock is considered to be overexploited.

The STECF EWG 13-12 considers necessary the establishment of demersal fish research surveys to monitor the dog fish stock across all national waters of the Black Sea, including Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine.The STECF EWG 13-12considers to enhancing the knowledge on the influence of environment and species interactions on abundance and survival of dogfish.

6.6.8.2 Medium term considerations

Given the current state of stock, EWG 13-12 considers than on medium term future to be reduced the fishing effort, undertake concerted actions to combat illegal fishing and to establish regional consultation mechanisms between the Black Sea coastal states.

6.7 Red mullet in the Black Sea

6.7.1 *Biological features*

6.7.1.1 Stock Identification

The red mullet (*Mullus barbatus*) is a demersal species in the Black Sea and Azov ecosystem. Red mullet inhabits temperate and tropical waters in small schooling groups. It distributes on sandy-muddy or wholly muddy bottoms feeding on crustacean and small invertebrates. According to sea water temperature it makes seasonal migrations for spawning and feeding (Whitehead et al., 1986). The stock is vulnerable to fishery all year long. Furthermore, its delicious meat raises it economical value. According to Ivanov and Beverton (1985) red mullet is a gregarious, demersal species, found on muddy bottoms or gravels and sandy bottoms of the continental shelf between 5m and 100m depth. In the spring, at temperature of 7-8 ^{o} C, appears near of the shore; when the water is warming at 15-16 ^{o} C, going back to bigger depths. Reproduction occursin the period June-September, on muddy or sandy bottoms, from 10m to 55m.

Red mullet is bottom benthic fish reaches a length of 20 cm and more, and the age of 10-12 years (Svetovidov, 1963), usually until 4–5 years old. Red mullet prefers waters with the temperature higher 8ºC and salinity more than 17‰. Red mullet spawns in June - September, on muddy or sandy bottoms, from 10 m to 55 m with a maximum in mid-summer. Eggs and juveniles (up to the age of 1.5 months) are pelagic; adults live near bottom, feeding on *Polychaetae*, crustaceans and mollusks. In the vicinity of the Crimean and Caucasus coasts, it is customarily distinguished in two particular forms – "settled" and migratory ones. In the waters ofUkraine and the RussianFederation migratory form has the greater commercial value, moving to the Kerch Strait and the Sea of Azov for fattening and spawning in spring and coming back to the coasts of the Crimea for wintering.Along coasts ofRomania andBulgaria inSeptember-November red mullet migrates to the Turkish waters of the Black Sea and Sea of Marmara for wintering. Some years it schools remain on the Bulgarian coast and die in cold winters.

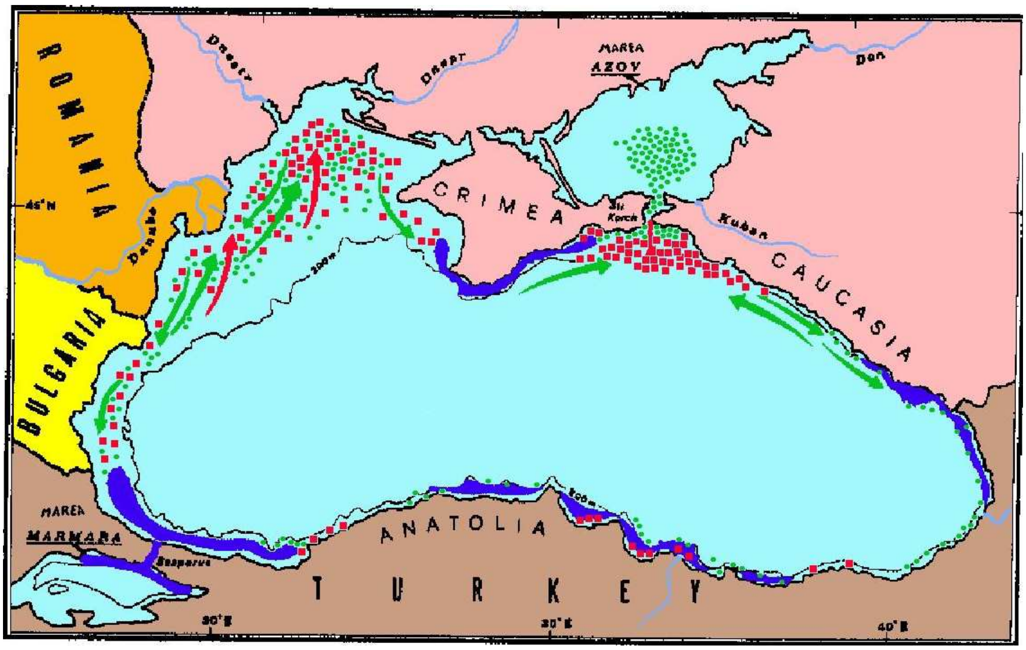
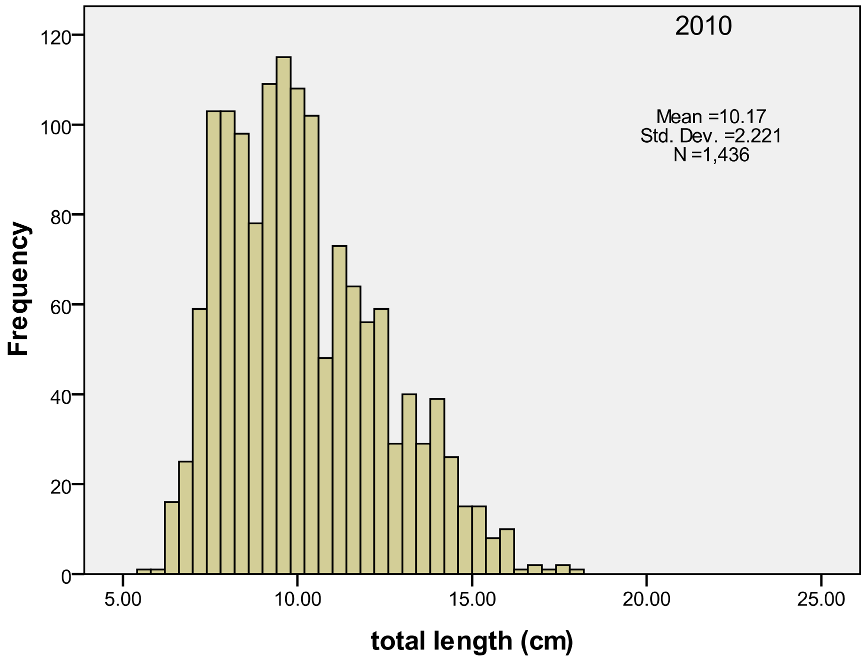


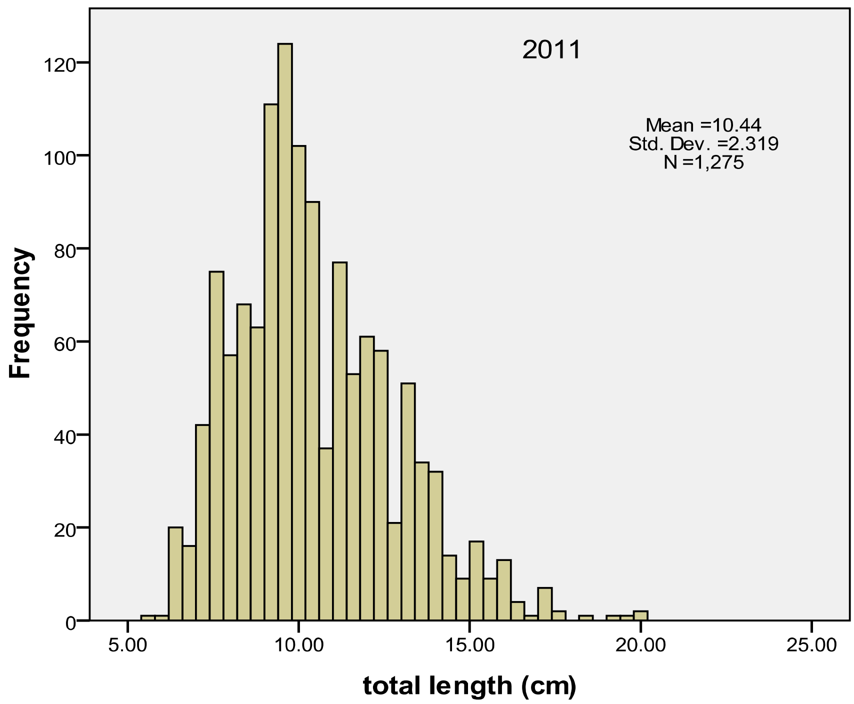
Figure 6.7.1.1.1. Migration routes, spawning, feeding and wintering areas for red mullet

In eastern Black Sea, a study about bio-ecological features of red mullet for 1991-1996 (Genç, 2000) reported that red mullet moves toward shallow waters to spawn in May and by the end of reproduction period (nearly August) it turns toward to 20-50 depths. By October-November it prefers deeper waters to spend the winter. At the end of reproduction period (August) recruitment is observed by 4-5 cm and 0+ age juveniles.

6.7.1.2 Growth, mortality

In south-eastern Black Sea; total lengths of the red mullet specimens ranged from 4.4 to 23.5 cm. Size ranges were 7.2-19.6 and 6.1-23.5 cm for males and females respectively, while mean total length values were estimated as 12.49 ±0.02 cm for whole population, 12.43±0.02 cm for males and 13.73±0.03 cm for females. Size differences between the sexes seemed to be significant in favour of females for the years 1991-1996 Genç (2000) and Süer (2008) reported that specimens of 9.5-14.5 cm are composing 73.5% of the samples in 2004-2006, the minimum length been 5.9 cm and the maximum length 22.6. Zengin et al (2012) reported a length range of 5.5-20.1 cm with average of 10.47 cm along southern Black Sea coast. The length frequency distributions of red mullet in 2010-2012 along southern Black Sea coast were presented in Figure 6.7.1.2.1.





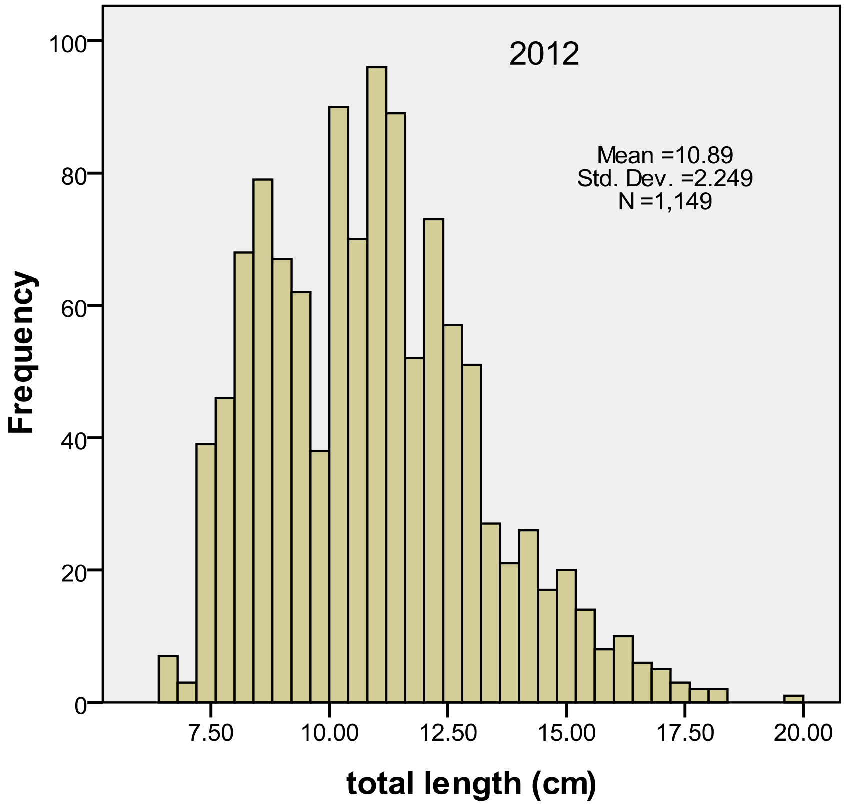


Figure 6.7.1.2.1. Length frequency distributions of red mullet along southern coast of Black Sea for 2010-2012.

Sex ratio in whole population is around 1:1, however, the ratio seems to vary between age and size groups. Males are dominant during the early ages, but after age of 3 and size of 14.5 cm, ratio change in favour of females. Maximum age is 9 years for females and 8 years for males. Fish from 0^+, 1^+ and 2^+ age groups consist of approximately 80% of the population. Genç (2000) and Süer (2008) determined that the sex ratio (M:F) was 1.55:1, 1.65:1 and 1.86:1 for 2004-2006 respectively. The longevity of red mullet was identified as six years with dominant age classes of age 2 (46.2%) and 1 (24.8%). Zengin et al. (2012) estimated the sex ratio of 0.77:1 in 2010-2012. The average age composition of red mullet population from various studies conducted in Turkish Black Sea coasts is presented in Table 6.7.1.2.1.

Table 6.7.1.2.1. The distribution of the population according to age groups in different studies in the Black Sea.

Researchers	Age groups									
	0+	1	2	3	4	5	6	7	8	9
Samsun and Erkoyuncu (1992)	-	50,43	21,36	19,14	7,51	1,13	0,43			
Şahin and Akbulut (1997)	-	34,69	31,15	14,59	8,42	6,25	4,89			
Genç(2000)	12.57	28.63	38.79	15.94	3.36	0.56	0.11	0.01	0.03	0,01
Genç(2002)	0,71	16,84	52,23	27,18	2,42	0,43	0,19			
Süer(2008)	10,4	24,8	46,2	15,2	2,5	0,6	0,1			

Aydın and Karadurmuş(2013)		10,66	39,86	35,89	7,39	4,18	1,11	0,91		
Zengin et al (2012)	14.2	49.2	22.3	8.6	4.9	0.3	0.1			

Table 6.7.1.2.2. VBGF parameters for mullet calculated in the Black Sea

COUNTRY	YEAR-PERIOD	SPECIES	SEX	L_INF	K	t_0	a	b	Reference
Ukraine	1988-1990	MUT	C	17.97*	0.316	-1.876	0.0085	3.338	Domashenko (1990)
Turkey	1991-1996	MUT	F	25.55	0.238	-1.324	0.0064	3.177	Genç (2000)
	1991-1996	MUT	M	23.83	0.227	-1.624	0.0074	3.114	Genç (2000)
Turkey	2004-2006	MUT	M	25.25	0.154	-1.59	0.07	3.17	Süer (2008)
Turkey	2004-2006	MUT	F	39.36	0.082	-1.92	0.07	3.14	Süer (2008)
Turkey	2004-2005	MUT	C	20.15	0.33		0.0107	2.9717	Aksu et al, 2011
Turkey	2010	MUT	C	18.97	0.486	-0.961	0.007	3.15	Zengin et al.(2012)
Turkey	2011	MUT	C	20.66	0.442	-1.327	0.007	3.15	Zengin et al.(2012)
Turkey	2012	MUT	C	21.37	0.409	-1.479	0.006	3.21	Zengin et al.(2012)

* - standard length (SL)

According to various authors (Table 7) in the period 1991-1996, total mortality rates (Z) ranged from 1.16 to 1.51, natural mortality rate (M) 0.36-0.44, and fishing mortality (F), 0.62-1.08 while overall mean values are calculated as Z=1.41, M=0.39 and F=1.02. Estimated total biomass values in entire eastern Black Sea were 1329, 3011 and 4850 tons during 1990-1992, respectively. Selectivity values (L_{50}) have been calculated as 12.57, 13.19 and 13.77 cm for trawl with cod-end mesh sizes of 18, 20 and 22 mm, respectively (Genç, 2000).

Aksu et al. (2011) reported some population parameters of red mullet from southern-middle Black Sea for the years of 2004-2005 as $W=0.0107L^{2.9717}$, L_{inf} =20.15, K=0.33, M=0.68 and F=0.60.

Table 6.7.1.2.2 reveals the data from various studies regarding mortality and exploitation rates of red mullet population.

Table 6.7.1.2.2. Mortality and exploitation rates of red mullet population

	Mortality			**Exploitation rate**	**Sampling year**
	Total mortality (Z)	Natural mortality (M)	Fishing mortality (F)	(E)	
Bingel *et al.* (1996)	6.17	0,92	5.25	0,80	1991
	5.97	0,91	5.06	0,80	1992
Genç (2000)	1,41	0,36	1,05	0.74	1991

	1,42	0,43	0,99	0.70	1992
	1,51	0,43	1,08	0.72	1993
	1,16	0,44	0,72	0.62	1994
	1,41	0,41	1,00	0.71	1995
	1,36	0,39	0,97	0.71	1996
	1,41	0,39	1,02	0.72	1991-96
Genç *et al.* (2002)	2,30	0,37	1,93	0,84	2000
Aksu *et al.* (2011)	1,28	0,68	0,60	0,47	2004-2005
Zengin et al (2012)	1.463	0.661	0.802	0.55	2010-2012

In Ukrainian waters; there are differencesin the growth betweensettled andmigratory forms of red mullet. The migratory form has a higher growthrate. The parameters of VBGF, the length-weight relationships and natural mortality M were estimated by Domashenko (1990).

Migratory form: K= 0.316 t_0= -1.876; SL_∞= 17.97 cm; W_∞= 100.5 g

$W= 0.0085 \times L^{3.338}$; $M = 0.8$

Length-based Cohort Analysis (LCA Jones method) has been performed in Ukrainian waters of the Black Sea in 2000-2012 The results show (Table 6.8.1.2.2) that average fishing mortality have increased but not as high as the reference level of $F_{0.1}$=0.6. In the period 2010-2012 the average fishing mortality of 0.566 comes close to $F_{0.1}$.

Table 6.7.1.2.3. Fishing mortality of red mullet in Ukrainian Black Sea waters in 2000-2012

	F_i				
Sl_i. mm	2000-2002	2003-2005	2006-2008	2009-2011	2010-2012
61-65	0.000	0.000	0.000	0.000	0.000
66-70	0.000	0.000	0.001	0.000	0.000
71-75	0.001	0.000	0.007	0.002	0.002
76-80	0.002	0.001	0.014	0.023	0.006
81-85	0.016	0.013	0.036	0.073	0.029
86-90	0.085	0.053	0.128	0.273	0.080
91-95	0.136	0.079	0.237	0.501	0.096
96-100	0.278	0.141	0.335	0.505	0.184
101-105	0.437	0.232	0.412	0.734	0.271
106-110	0.414	0.312	0.506	0.962	0.354
111-115	0.453	0.377	0.544	0.934	0.397
116-120	0.467	0.449	0.609	1.016	0.484
121-125	0.695	0.619	0.605	0.767	0.563
126-130	0.756	0.561	0.658	0.727	0.618
131-135	1.006	0.557	0.689	1.894	0.690
136-140	1.177	0.572	0.700	1.774	0.754
141-145	1.269	0.515	0.747	2.394	0.877
146-150	3.334	0.749	0.808	1.948	0.928
151-155	2.703	0.590	0.750	2.703	1.141
$Fav._{91-155}$	0.161	0.121	0.174	0.257	0.566

6.7.1.3 Maturity

In eastern Black Sea Genç (2000) reported that the first sexual maturity is attained at 10.17 cm in males and 11.28 cm in females. In general, fish of these sizes are at age of one. Red mullets in this region spawn from end of May up to beginning of August. Spawning take place in surface layers of above 20 m at 18-25°C, salinity of 17-18‰ and dissolved oxygen concentrations of 6-9 mg/L. Mean size of ovulated egg ready for release has been measured as 756±2.21 (545-1050) μ and average relative fecundity is 149.7±8.97 eggs/g.

In Ukraine, the migratory form of red mullet matures at ages of 1+ (the main part recruitments of the spawning stock) or 2+ (Sirotenko.and Danilevsky, 1979). In the Sea of Azov red mulletnot breed. Even ifred mullet at ages of 1+ with maturinggonadscome into the Sea of Azov, it will be absorbed.

6.7.2 *Fisheries*

6.7.2.1 General description

Red mullet is one of the most important fish species fished and consumed traditionally in the Black Sea countries. In Turkey, it is mostly caught by bottom trawls as a target fish species. Red mullet is the second species after whiting composing 9.5% of total demersal catches between 1991 and 1996 (Genç, 2000). The gillnets are also allowed in red mullet fishery all along Turkish coasts and through all seasons but only 10% of total landing obtained by this method.

Catches of red mullet in EU waters are taken primarily by Bulgaria (131.5 t during 2012, 19% of the Black Sea total), with only small amounts landed by Romanian fishers (1.4 t during 2012, about 0.2% of the Black Sea total).

In the waters of Georgia according to the data of official statistics in 1989 – 1996 catches of red mullet were absent or was categorized within the “other fish” group. In 1997 – 2005, its mean annual catch was equal to 28 tons. According to Komakhidze *et al.* (2003), the red mullet was captured recently in higher amounts that provided an indirect evidence of increasing abundance.

Along the coasts of the Russian Federation target fisheries of red mullet are performed mainly with passive fishing gears. The stocks exceeded over 100 tons by 1998 which was mainly related to the reduction of *Mnemiopsis leidyi* population (Volovik and Agapov, 2003). In 2002, the total biomass was estimated as 1200 tons exploited biomass as 960 tons and TAC as 200 tons.

In Ukrainian waters, target fishing of the red mullet was permitted only with beach seines and bottom set traps; however, the greater part of its catches corresponded to the non-target fishing with bottom traps (Shlyakhov and Charova, 2003). The major share of red mullet was harvested in autumn in Balaklava Bay, near Sebastopol. The amount of non-registered catches of red mullet cannot be evaluated at present. Spawning stock biomass (SSB), recruitment (R) and TAC of red mullet estimated with LCA are in Ukrainian waters are presented in Fig 6.7.2.1.1.

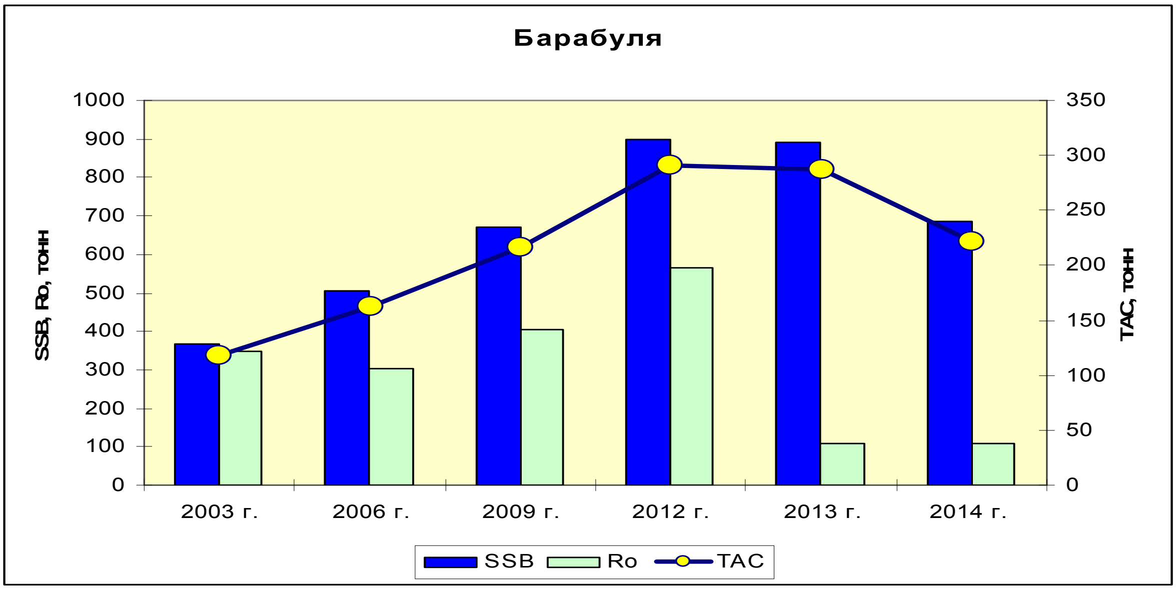


Fig 6.7.2.1.1 Jones method results for Crimean stock of red mullet in Ukrainian waters of the Black Sea for 2003-2012 and prediction for 2013-2014.

6.7.2.2 Management regulations applicable in 2010 and 2012

In Turkeythe red mullet fishery is regulated by area and season closures of the fisheries:

(1)Area closures: Bottom trawling is prohibited in waters between a) Sinop city. İnceburun (42° 05.959' N-34° 56.695' E) and Samsun city Çayağzı cape (41° 41.040' N-35° 25.193' E), b) Ordu city; Ünye. Taşkana cape (41° 08.725' N-37° 17.531' E) and Georgia border. Furthermore, it is also banned within 2 miles from land between Zonguldak city; Ereğli. Baba cape (41° 17.342' N-31° 23.937' E) and Bartın city; Amasra. Tekke cape (41° 43.485' N-32° 19.258' E) (Figure 1). In other areas open to trawling allowed distance is 3 miles.

(2) Time closures: In open areas, turbot fishery with bottom trawling is banned between April 15 and September 15. Gillnets were allowed all along the Turkish coasts for red mullet fishery except April 15-June 15.

(3) Mesh size limitations: Cod end mesh size should not be lower than 40 mm in bottom trawl nets.

(4) Minimum legal catch size: Minimum legal size (total length) was determined as 13 cm for all kind of fishing gears.

In Ukraine fisheries regulations set the minimum commercial fishing size for red mullet as 8.5 cm (SL); the allowable by-catch of juveniles in non-target fishery to be no more than 8% of the total weight of a haul and in target fishery – no more than 20%of the catch.The mesh size in beach seines and in scrapers cannot should no less than 10 mm.

Bottom-trawling is prohibited in Bulgaria. Closed season for all coastal fisheries is between 15 April to 15 June.

Minimum landing size of red mullet in the Black sea region are presented in Table. 6.8.2.2.1

Table. 6.7.2.2.1Minimum landing size of red mullet in the Black sea region

	BG	GE	RO	RU	TR	UK
Mullus barbatus	TL=12cm	SL=8.5cm	no	SL= 8.5 cm	TL=13.0	SL=8.5cm

6.7.2.3 Catches

6.7.2.3.1 *Landings*

Landings of the red mullet in the Black Sea were reported by the Black Sea countries (Table 6.7.2.3.1.1.) and some particular data from Ukraine. General trends in amount of landings appear different for countries (Figure 6.7.2.3.1.1). Landings significantly decreased by fluctuations in the last 15 years in Turkish data where a remarkable increase arise in Bulgarian catch in 2011. Ukraine and Russian catches of red mullet were relatively constant for the last ten and twenty years respectively.

Table 6.7.2.3.1.1 Red mullet landings (tons) in the Black Sea.

Years	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
1988				129		
1989				324		
1990				132		
1991				210		
1992				37		
1993				2		
1994				25		
1995				324		
1996				76	2249	
1997				68	1173	
1998				119	1423	
1999				92	1853	
2000	5.0			127	910	10.3
2001	26.0			119	1110	20.9
2002	33.0			47	867	40.7
2003	36.0			177	506	35.8
2004	17.0			99	668	23.0
2005	1.0			151	1093	17.5
2006	6.0			140	960	56.1
2007	12.5			87	781	54.4
2008	17.0			115	706	48.9
2009	48.2			291.65	799	65.2
2010	72.4			200.28	507	68.2
2011	176.2	22	1.9	290.94	326.1	58.2
2012	131.5		1.37	144.4	347.3	78.9

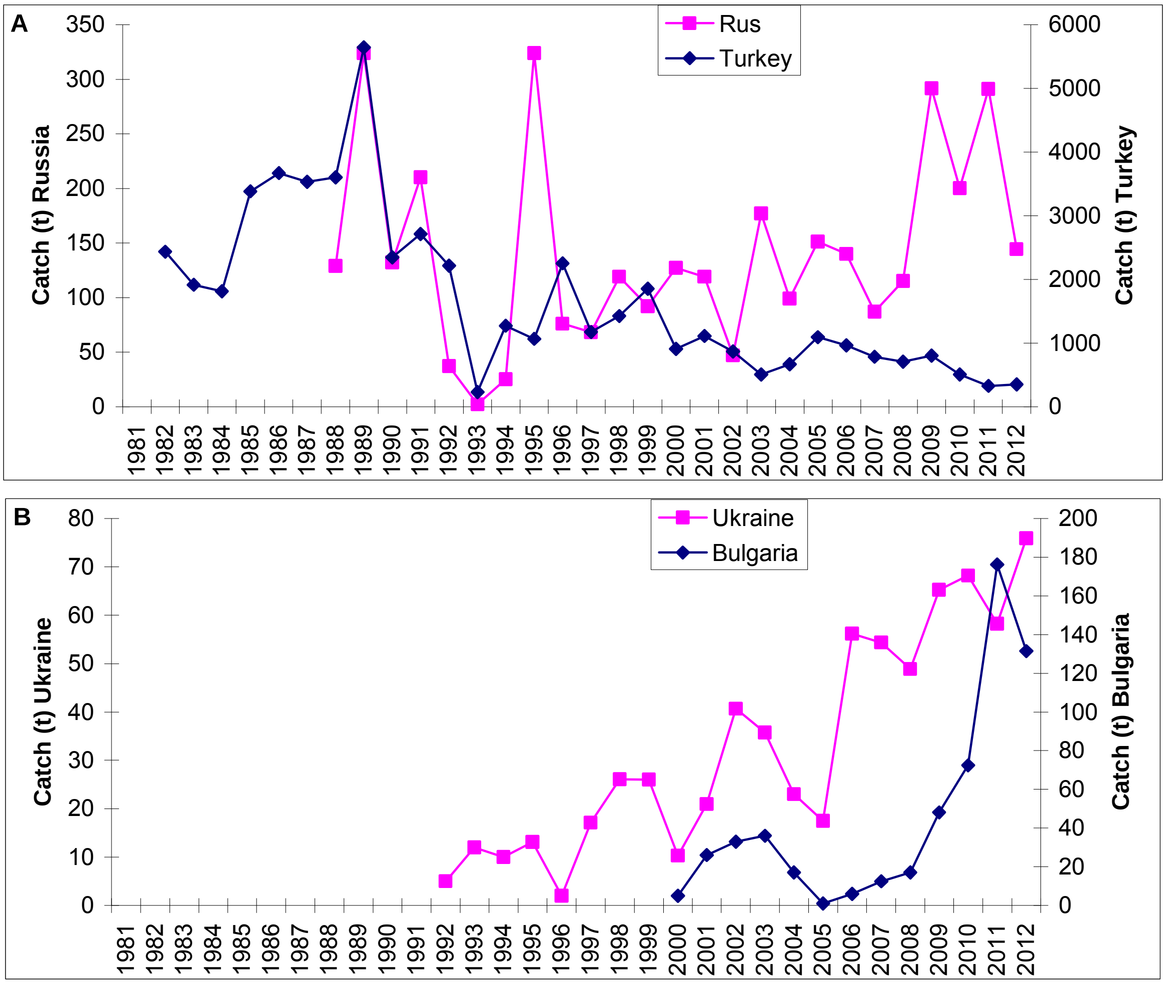


Figure 6.7.2.3.1.1Trends in landing of red mullet in Black Sea countries

6.7.2.3.2*Discards*

No information has been presented at the EWG 13-12 meeting

6.7.2.4 Fishing effort

No information has been presented at the EWG 13-12 meeting

6.7.2.5 Commercial CPUE

No information has been presented at the EWG meeting

6.7.3 *Scientific Surveys*

6.7.3.1 CPUE and CPUA indices

The mean catches per unit effort (CPUE) and abundance index (CPUA) are estimated respectively as 7.75 kg/km^2 and 16.58 kg/km^2 (Table 6.7.3.1.1.). Trawl samplings conducted is generally below of 40 m (minimum 24.7 m, maximum 113.0 m) depths along in the SSA and WBS littorals zones. The stock is localized under the layer of 30-50 m generally. The surveys period is included 7 months (from January to April and from September). Abundance indices were estimated by 'swept area method' from commercial vessels (Sparre and Venema, 1992). It is also given biomass indices of pooled data by mapping two parts of Turkish Black Sea (Figure 3a and b).

Table 6.7.3.1.1. Descriptive data regarding CPUE (kg/h) and abundance indices CPUA (kg/km^2) of red mullet for 2011 and 2012 in the Samsun shelf area (SSA) and West Turkish Black Sea

Region	No of hauls	Minimum	Maximum	Mean	Std. Error	Std. Deviation
CPUE/GENERAL	104	0.00	53.30	7.75	1.08	10.99
CPUA/GENERAL	104	0.00	125.10	16.58	2.44	24.89
CPUE/SSA (EBS)	60	0.00	37.90	7.70	1.31	10.14
CPUE/ WBS	44	0.00	53.30	7.82	1.84	12.19
CPUA/ SSA (EBS)	60	0.00	80.00	15.97	2.82	21.87
CPUA/WBS	44	0.00	125.00	17.41	4.33	28.74

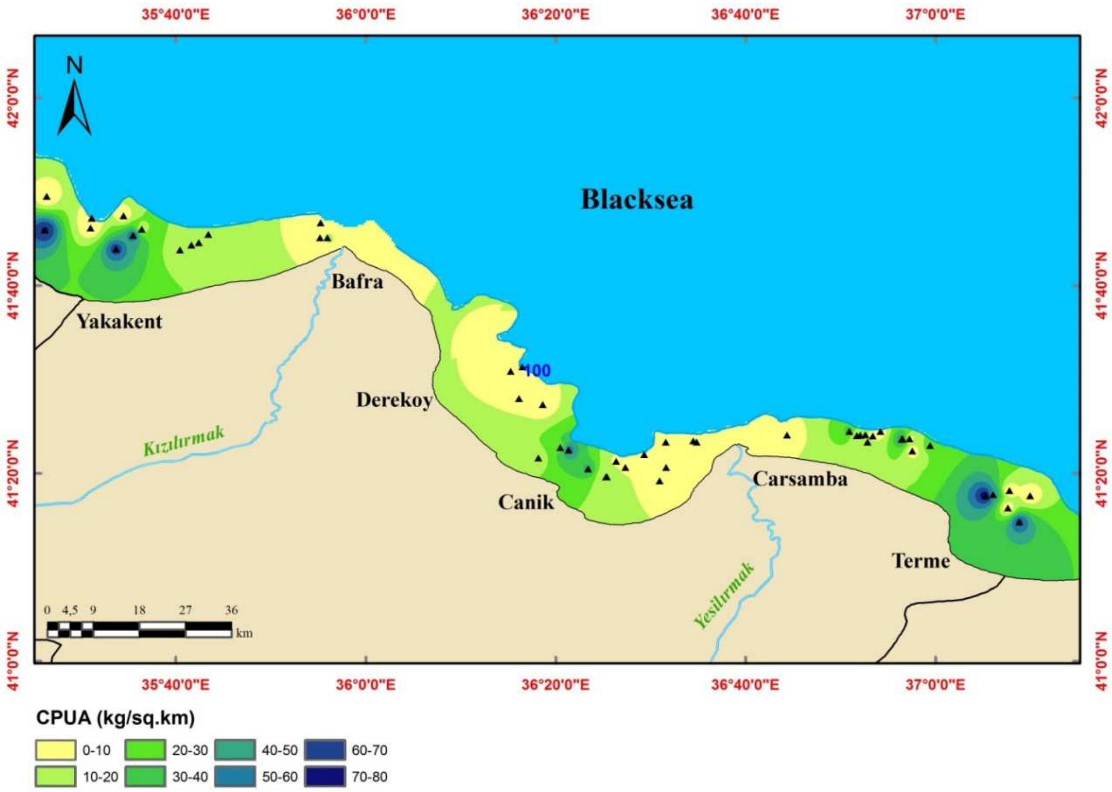
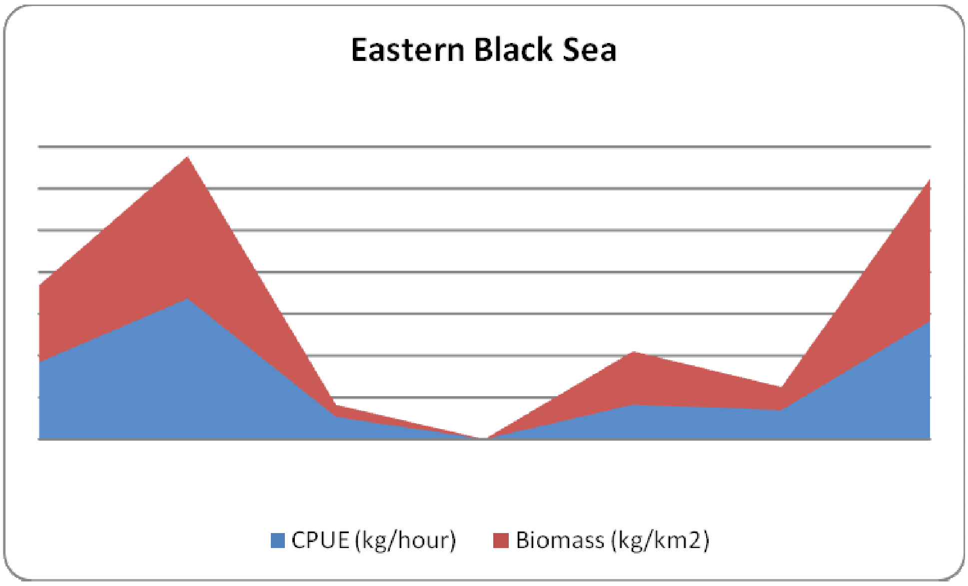


Figure 6.7.3.1.1. Map of biomass indices in the Samsun Shelf Area, 2012 (This mapping is coverage all data).

Figure 6.7.3.1.2. Map of biomass indices in the West Black Sea Turkish Region, 2012 (This mapping is coverage all data).



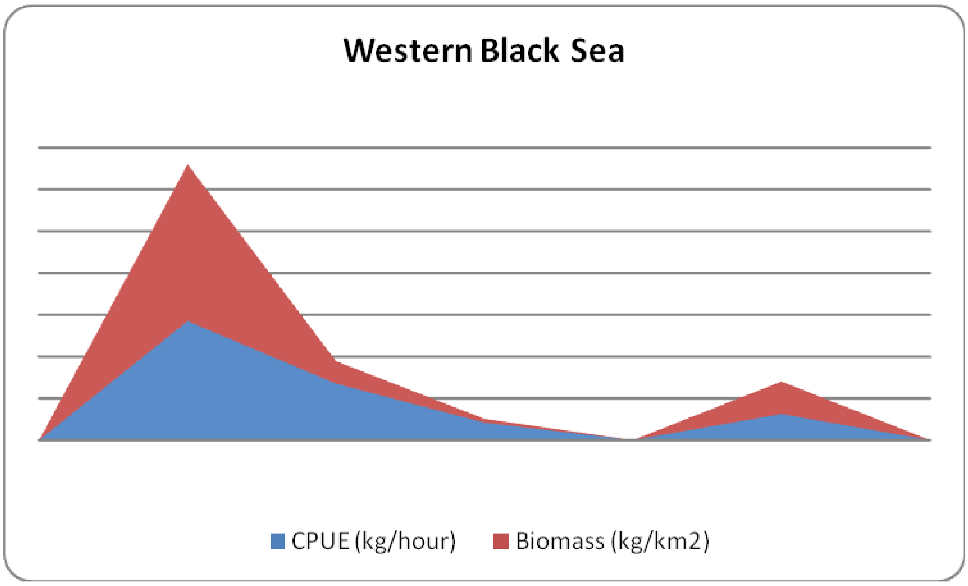


Figure 6.7.3.1.3. Monthly variation of CPUE and Biomass data of red mullet along Turkish coasts

Table6.7.3.1.1. Tuning data from the Turkish bottom-trawl survey 2009-2012 in thousand numbers per 1 hour of trawling at age

Red Mullet 2012 TUNING DATA

	Age 1	Age 2	Age 3	Age 4	Age 5
2009	672	282	58	13	3
2010	531	261	61	13	1
2011	718	250	40	11	4
2012	387	130	35	16	1

6.7.4 *Assessment of historic parameters*

6.7.4.1 Method 1: XSA

6.7.4.1.1 *Justification*

The EWG 13-12 found out that data available in different national databases would allow performing a quantitative assessment of the red mullet stock. The data available for the period 1990 to 2012 of landings, catch at ages 0 - 6+, weights at age in the stock and weights at age, maturity at age and natural mortality were considered appropriate for the application of the XSA. Turkish bottom-trawl survey data were used for tunning.

6.7.4.1.2 *Input parameters*

Input data are presented in Table 6.7.4.1.2.1. Catch at age matrix was constructed based on landing data from all Black Sea countries except Ukraine. As mentioned in the section of Stock Identification (6.7.1.1.), fisheries in Ukraine are considered to exploit a different stock than other Black Sea countries. Age composition from the Turkish fisheries (which is accounting for the majority of the catches) was used. Age structured data (2009-2012 ages 1-5) from the Turkish Bottom Trawl Survey ware used as atuning index.

Table 6.7.4.1.2.1 Input data for XSA of Red mullet in the Black Sea

Run title :Red mullet 2012

At 9/10/2013 16:22

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1990,	1991,	1992,
AGE			
0,	6555,	10900,	7299,
1,	21695,	23040,	27576,
2,	22335,	31049,	23289,
3,	16201,	20906,	15951,
4,	13952,	14274,	9771,
5,	1370,	1170,	734,
+gp,	406,	413,	232,
0 TOTALNUM,	82514,	101752,	84852,
TONSLAND,	2476,	2922,	2251,
SOPCOF %,	100,	100,	100,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	355,	2249,	3777,	7147,	3599,	3172,	1166,	625,	1447,	2042,
1,	1548,	13105,	12484,	16765,	10030,	24708,	52295,	28016,	28564,	14522,
2,	2009,	12086,	10890,	17589,	9555,	17439,	30966,	16589,	17782,	12718,
3,	1587,	8397,	8078,	13710,	7269,	8306,	8225,	4406,	5859,	9863,
4,	1396,	7097,	8624,	15118,	7891,	6823,	2148,	1151,	2969,	1100,
5,	90,	562,	1196,	1993,	1066,	917,	276,	148,	394,	280,
+gp,	51,	211,	189,	478,	213,	175,	31,	16,	66,	309,
0 TOTALNUM,	7036,	43707,	45238,	72800,	39623,	61540,	95107,	50951,	57081,	40834,
TONSLAND,	229,	1294,	1389,	2325,	1241,	1542,	1945,	1042,	1255,	947,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

1

Run title : mullet 2012

At 9/10/2013 16:22

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,
AGE										
0,	1550,	2211,	1728,	1434,	1499,	5702,	15685,	6838,	15573,	8021,
1,	11026,	11941,	19332,	16046,	12937,	25794,	54717,	34077,	41975,	31106,
2,	9656,	8458,	20648,	17138,	12529,	16252,	22929,	16728,	14632,	10482,
3,	7489,	7297,	14643,	12154,	9275,	8461,	4679,	3926,	2366,	2788,
4,	835,	719,	1810,	1502,	1091,	1154,	1098,	842,	650,	1322,
5,	213,	387,	82,	68,	156,	180,	210,	79,	225,	78,
+gp,	235,	387,	165,	137,	196,	167,	59,	1,	90,	1,
0 TOTALNUM,	31004,	31400,	58408,	48479,	37683,	57710,	99377,	62491,	75511,	53798,
TONSLAND,	719,	784,	1245,	1106,	881,	838,	1139,	780,	795,	623,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

1

Run title : mullet 2012

At 9/10/2013 16:22

Table 2 Catch weights at age (kg)

YEAR,	1990,	1991,	1992,
AGE			
0,	.0049,	.0049,	.0049,
1,	.0123,	.0123,	.0123,
2,	.0248,	.0248,	.0248,
3,	.0399,	.0399,	.0399,
4,	.0598,	.0598,	.0598,
5,	.0763,	.0763,	.0763,
+gp,	.0935,	.0935,	.0935,

0 SOPCOFAC, 1.0000, .9999, 1.0000,

Table 2 Catch weights at age (kg)

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	.0049,	.0049,	.0049,	.0049,	.0049,	.0058,	.0058,	.0058,	.0058,	.0046,
1,	.0123,	.0123,	.0123,	.0123,	.0123,	.0130,	.0130,	.0130,	.0130,	.0128,
2,	.0248,	.0248,	.0248,	.0248,	.0248,	.0263,	.0263,	.0263,	.0263,	.0231,
3,	.0399,	.0399,	.0399,	.0399,	.0399,	.0381,	.0381,	.0381,	.0381,	.0356,
4,	.0598,	.0598,	.0598,	.0598,	.0598,	.0516,	.0516,	.0516,	.0516,	.0576,
5,	.0763,	.0763,	.0763,	.0763,	.0763,	.0698,	.0698,	.0698,	.0698,	.0727,
+gp,	.0935,	.0935,	.0935,	.0935,	.0935,	.0658,	.0658,	.0658,	.0658,	.0785,
0 SOPCOFAC,	.9998,	1.0000,	.9999,	.9999,	.9999,	.9998,	.9992,	.9993,	.9995,	.9988,

1

Run title : mullet 2012

At 9/10/2013 16:22

Table 2 Catch weights at age (kg)

YEAR,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,
AGE										
0,	.0046,	.0062,	.0030,	.0030,	.0046,	.0039,	.0039,	.0040,	.0037,	.0040,
1,	.0128,	.0144,	.0112,	.0113,	.0128,	.0088,	.0088,	.0088,	.0088,	.0088,
2,	.0231,	.0247,	.0215,	.0225,	.0231,	.0178,	.0178,	.0183,	.0179,	.0173,
3,	.0356,	.0389,	.0322,	.0357,	.0356,	.0270,	.0270,	.0279,	.0258,	.0274,
4,	.0576,	.0652,	.0500,	.0572,	.0576,	.0392,	.0392,	.0376,	.0390,	.0409,
5,	.0727,	.0736,	.0719,	.0721,	.0727,	.0579,	.0579,	.0535,	.0566,	.0634,
+gp,	.0785,	.0790,	.0780,	.0735,	.0785,	.0866,	.0866,	.0866,	.0866,	.0866,
0 SOPCOFAC,	.9987,	.9995,	.9989,	1.0000,	.9992,	1.0011,	1.0014,	1.0015,	.9990,	1.0006,

1

Run title : mullet 2012

At 9/10/2013 16:22

Table 3 Stock weights at age (kg)

YEAR,	1990,	1991,	1992,
AGE			
0,	.0049,	.0049,	.0049,
1,	.0123,	.0123,	.0123,
2,	.0248,	.0248,	.0248,
3,	.0399,	.0399,	.0399,
4,	.0598,	.0598,	.0598,
5,	.0763,	.0763,	.0763,
+gp,	.0935,	.0935,	.0935,

Table 3 Stock weights at age (kg)

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	.0049,	.0049,	.0049,	.0049,	.0049,	.0058,	.0058,	.0058,	.0058,	.0046,
1,	.0123,	.0123,	.0123,	.0123,	.0123,	.0130,	.0130,	.0130,	.0130,	.0128,
2,	.0248,	.0248,	.0248,	.0248,	.0248,	.0263,	.0263,	.0263,	.0263,	.0231,
3,	.0399,	.0399,	.0399,	.0399,	.0399,	.0381,	.0381,	.0381,	.0381,	.0356,
4,	.0598,	.0598,	.0598,	.0598,	.0598,	.0516,	.0516,	.0516,	.0516,	.0576,
5,	.0763,	.0763,	.0763,	.0763,	.0763,	.0698,	.0698,	.0698,	.0698,	.0727,
+gp,	.0935,	.0935,	.0935,	.0935,	.0935,	.0658,	.0658,	.0658,	.0658,	.0785,

1

Run title : mullet 2012

At 9/10/2013 16:22

Table 3 Stock weights at age (kg)

YEAR,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,
AGE										
0,	.0046,	.0062,	.0030,	.0030,	.0046,	.0039,	.0039,	.0040,	.0037,	.0040,
1,	.0128,	.0144,	.0112,	.0113,	.0128,	.0088,	.0088,	.0088,	.0088,	.0088,
2,	.0231,	.0247,	.0215,	.0225,	.0231,	.0178,	.0178,	.0183,	.0179,	.0173,
3,	.0356,	.0389,	.0322,	.0357,	.0356,	.0270,	.0270,	.0279,	.0258,	.0274,
4,	.0576,	.0652,	.0500,	.0572,	.0576,	.0392,	.0392,	.0376,	.0390,	.0409,
5,	.0727,	.0736,	.0719,	.0721,	.0727,	.0579,	.0579,	.0535,	.0566,	.0634,

+gp,	.0785,	.0790,	.0780,	.0735,	.0785,	.0866,	.0866,	.0866,	.0866,	.0866,

1

Run title : mullet 2012

At 9/10/2013 16:22

Table 4 Natural Mortality (M) at age

YEAR,	1990,	1991,	1992,
AGE			
0,	.4400,	.4400,	.4400,
1,	.4400,	.4400,	.4400,
2,	.4400,	.4400,	.4400,
3,	.4400,	.4400,	.4400,
4,	.4400,	.4400,	.4400,
5,	.4400,	.4400,	.4400,
+gp,	.4400,	.4400,	.4400,

Table 4 Natural Mortality (M) at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,
1,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,
2,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,
3,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,
4,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,
5,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,
+gp,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,	.4400,

1

Run title : mullet 2012

At 9/10/2013 16:22

Table 4 Natural Mortality (M) at age

YEAR,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,
AGE										
0,	.4400,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
1,	.4400,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
2,	.4400,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
3,	.4400,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
4,	.4400,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
5,	.4400,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
+gp,	.4400,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,

1

Run title : mullet 2012

At 9/10/2013 16:22

Table 5 Proportion mature at age

YEAR,	1990,	1991,	1992,
AGE			
0,	.0000,	.0000,	.0000,
1,	.6000,	.6000,	.6000,
2,	.8000,	.8000,	.8000,
3,	1.0000,	1.0000,	1.0000,
4,	1.0000,	1.0000,	1.0000,
5,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,
2,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,
3,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
4,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

1

```
Run title : mullet 2012

At  9/10/2013  16:22


    Table  5    Proportion mature at age
    YEAR,       2003,    2004,    2005,    2006,    2007,    2008,    2009,    2010,    2011,    2012,

    AGE
      0,        .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,   .0000,
      1,        .6000,   .6000,   .6000,   .6000,   .6000,   .6000,   .6000,   .6000,   .6000,   .6000,
      2,        .8000,   .8000,   .8000,   .8000,   .8000,   .8000,   .8000,   .8000,   .8000,   .8000,
      3,       1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
      4,       1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
      5,       1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
    +gp,       1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,  1.0000,
```

Red Mullet 2012 TUNING DATA   Numbers*10**-3

	Age 1	Age 2	Age 3	Age 4	Age 5
2009	672	282	58	13	3
2010	531	261	61	13	1
2011	718	250	40	11	4
2012	387	130	35	16	1

6.7.4.1.3*Results*

Parameters and options in applying XSA on the Red mullet are shown in Table 6.7.4.1.3.1. Final estimates were made with applying shrinkage to the mean F of the final 5 years. Retrospective analyses (Figure 6.7.4.1.3.1.) have not shown pervasive patterns.

Table 6.7.4.1.3.1 Parameters and options for XSA of Red mullet in the Black Sea

```
Lowestoft VPA Version 3.1

    3/10/2013  16:42

 Extended Survivors Analysis

Red mullet 2012

 CPUE data from file tun2012.dat

 Catch data for  23 years. 1990 to 2012. Ages  0 to   6.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 TUR BT              ,   2009, 2012,   1,     5,   .000,  1.000


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    3


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   5 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =    .010

      Minimum standard error for population
      estimates derived from each fleet =    .300
```

```
Prior weighting not applied

Tuning converged after    12 iterations
```

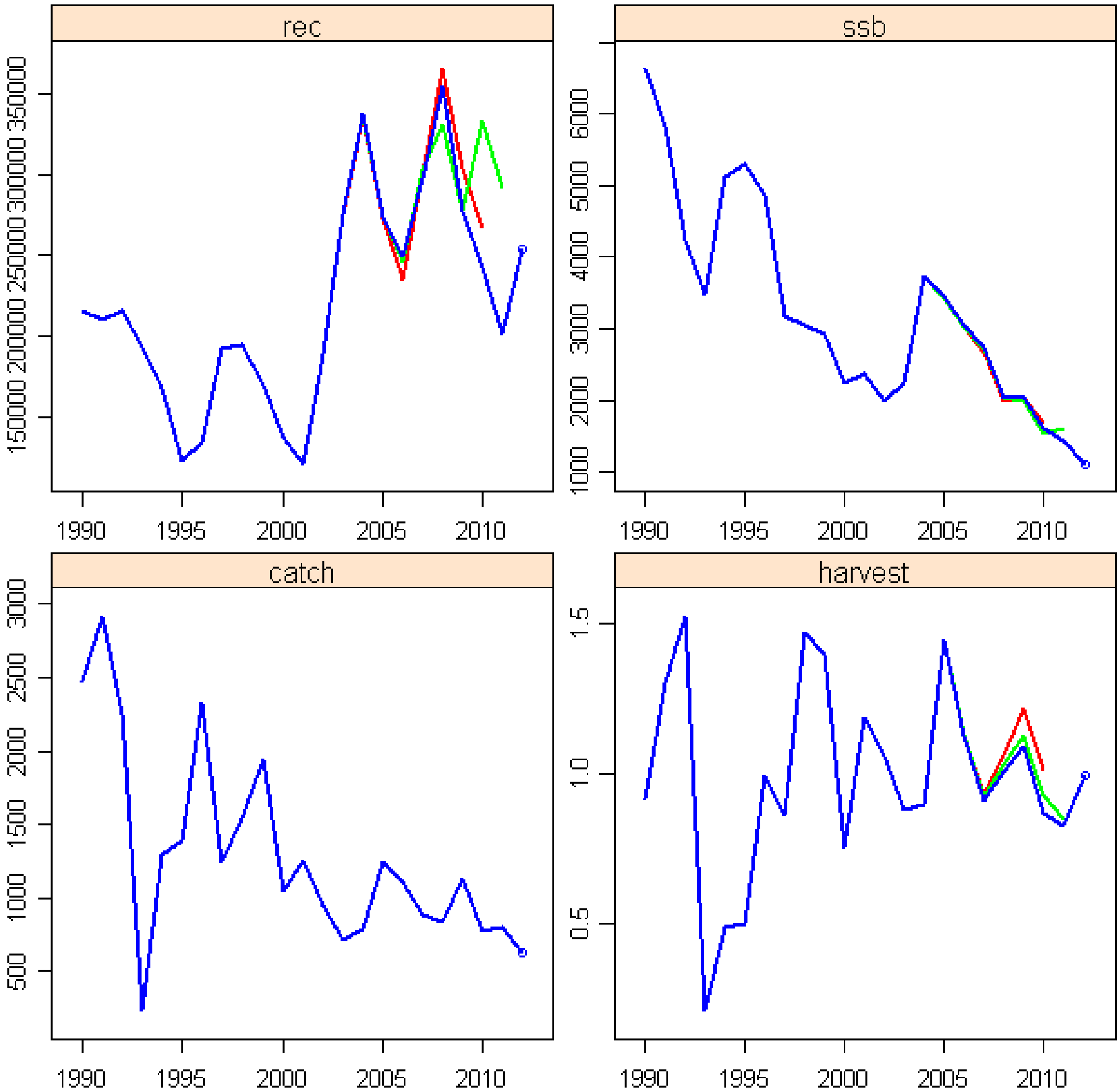


Figure 6.7.4.1.3.1. Retrospective analyses of Red mullet in the Black Sea

Residuals between observed and estimated log catchabilities of the tunning index are relatively small and no systematic patterns are detected (Figure).

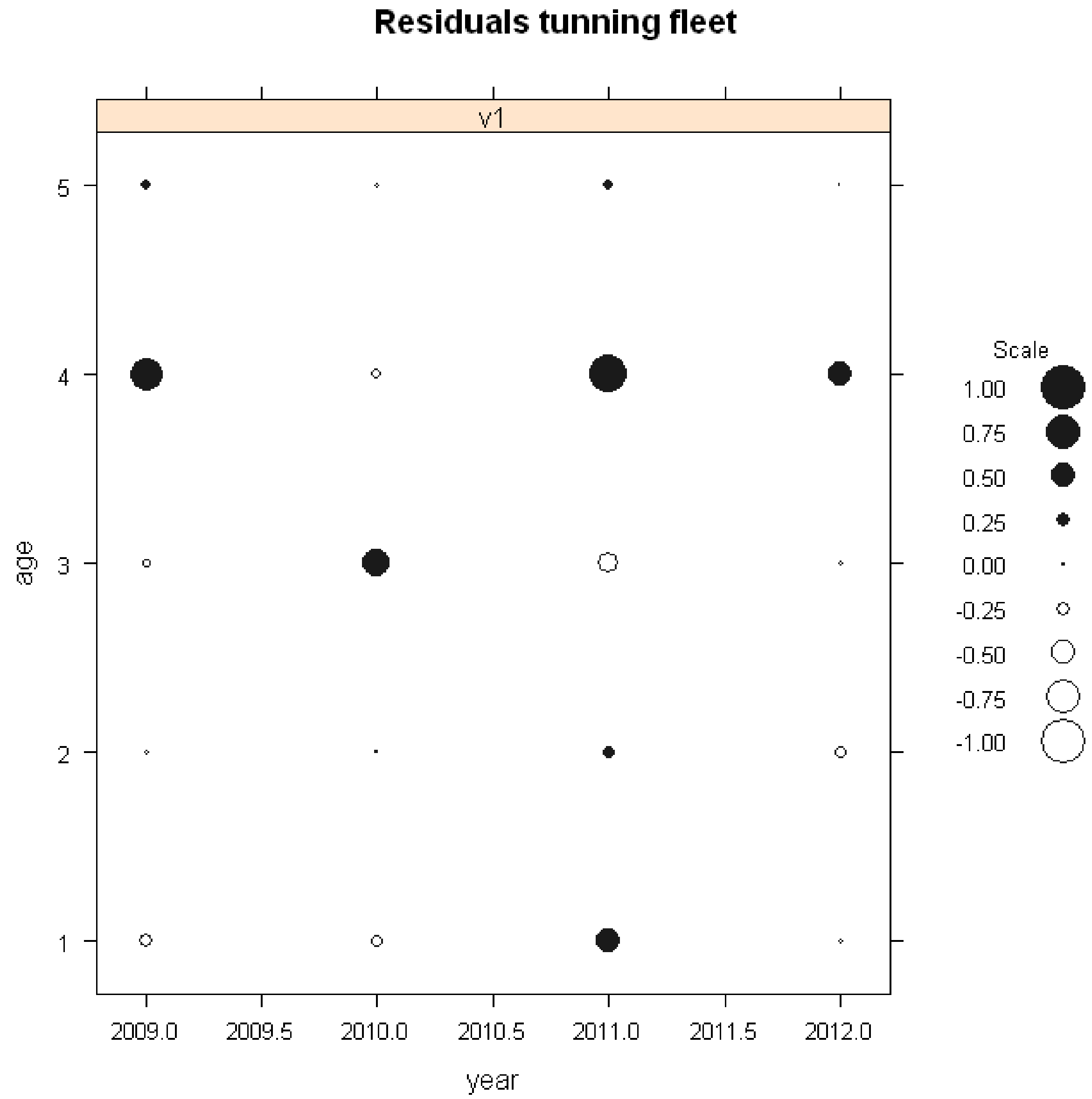


Figure 6.7.4.1.3.2Residuals between observed and estimated log catchabilities of the tunning index in Red mullet

Table 6.7.4.1.3.2 Diagnostics of the XSA on Red mullet in the Black Sea

```
 Regression weights
       ,  .990,  .997, 1.000, 1.000



 Fishing mortalities
    Age,  2009,  2010,  2011,  2012

      0,  .087,  .040,  .089,  .051
      1,  .625,  .528,  .731,  .491
      2, 1.052,  .800,  .965,  .818
      3,  .822, 1.085,  .446, 1.030
      4, 1.433,  .646, 1.119, 1.054
      5,  .843,  .648,  .701,  .720



1
 XSA population numbers (Thousands)

                                AGE
 YEAR ,           0,            1,            2,            3,            4,            5,

2009 ,    2.71E+05, 1.70E+05, 5.08E+04, 1.20E+04, 2.08E+03, 5.31E+02,
 2010 ,    2.52E+05, 1.20E+05, 4.38E+04, 8.54E+03, 2.55E+03, 2.39E+02,
 2011 ,    2.62E+05, 1.17E+05, 3.40E+04, 9.47E+03, 1.39E+03, 6.43E+02,
 2012 ,    2.34E+05, 1.16E+05, 2.70E+04, 6.25E+03, 2.92E+03, 2.19E+02,

Estimated population abundance at 1st Jan 2013

    ,     0.00E+00, 1.07E+05, 3.41E+04, 5.75E+03, 1.07E+03, 4.91E+02,

 Taper weighted geometric mean of the VPA populations:

    ,     2.45E+05, 1.25E+05, 4.68E+04, 1.40E+04, 2.80E+03, 5.04E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .2899,    .2295,    .3092,    .4482,    .5085,    .7518,
1

 Log catchability residuals.



 Fleet : TUR BT

  Age  ,  2009,  2010,  2011,  2012
     1 ,  -.08,  -.01,   .40,  -.31
     2 ,   .00,  -.02,   .25,  -.23
     3 ,  -.11,   .38,  -.39,   .12
     4 ,   .37,  -.12,   .49,   .10
     5 ,   .06,  -.32,   .10,  -.20



 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time


    Age ,         1,          2,          3,          4,          5
 Mean Log q,   -4.8448,   -4.4319,   -4.5479,   -4.5479,   -4.5479,
 S.E(Log q),     .2946,     .1960,     .3276,     .3673,     .2267,



 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    1.40,    -.255,      2.10,     .17,      4,     .50,   -4.84,
  2,     .83,     .436,      5.49,     .76,      4,     .19,   -4.43,
  3,    2.07,    -.669,      -.32,     .16,      4,     .75,   -4.55,
  4,    3.27,   -2.015,     -3.23,     .28,      4,     .63,   -4.34,
  5,     .74,    4.465,      4.97,     .99,      4,     .06,   -4.64,
1
```

```
Terminal year survivor and F summaries :

Age  0   Catchability constant w.r.t. time and dependent on age

Year class = 2012

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
TUR BT               ,         1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,    107351.,    .01,,,,                       1.000,     .051

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   107351.,       .01,      .00,    1,    .000,   .051


Age  1   Catchability constant w.r.t. time and dependent on age

Year class = 2011

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
TUR BT               ,     25126.,   .329,       .000,    .00,   1,  .001,     .620

  F shrinkage mean  ,     34109.,    .01,,,,                        .999,     .490

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    34103.,       .01,      .31,    2,  30.570,   .491


1
Age  2   Catchability constant w.r.t. time and dependent on age

Year class = 2010

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
TUR BT               ,      5467.,   .234,       .283,   1.21,   2,  .001,     .846

  F shrinkage mean  ,      5748.,    .01,,,,                        .999,     .818

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     5748.,       .01,      .04,    3,   3.588,   .818


Age  3   Catchability constant w.r.t. time and dependent on age

Year class = 2009

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
TUR BT               ,      1235.,   .225,       .060,    .27,   3,  .000,     .943

  F shrinkage mean  ,      1075.,    .01,,,,                       1.000,    1.030

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1075.,       .01,      .08,    4,   8.020,  1.030


1
Age  4   Catchability constant w.r.t. time and age (fixed at the value for age)  3

Year class = 2008

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
TUR BT               ,       447.,   .208,       .120,    .58,   4,  .001,    1.116

  F shrinkage mean  ,       491.,    .01,,,,                        .999,    1.054
```

```
Weighted prediction :

Survivors,        Int,      Ext,     N,     Var,      F
at end of year,   s.e,      s.e,      ,   Ratio,
      491.,       .01,      .05,     5,   4.685,  1.054


Age  5   Catchability constant w.r.t. time and age (fixed at the value for age)  3

Year class = 2007

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
TUR BT              ,        48.,   .241,       .151,     .63,   4,  .001,     .756

  F shrinkage mean  ,        51.,    .01,,,,                          .999,     .720

Weighted prediction :

Survivors,        Int,      Ext,     N,     Var,      F
at end of year,   s.e,      s.e,      ,   Ratio,
       51.,       .01,      .03,     5,   3.418,   .720
```

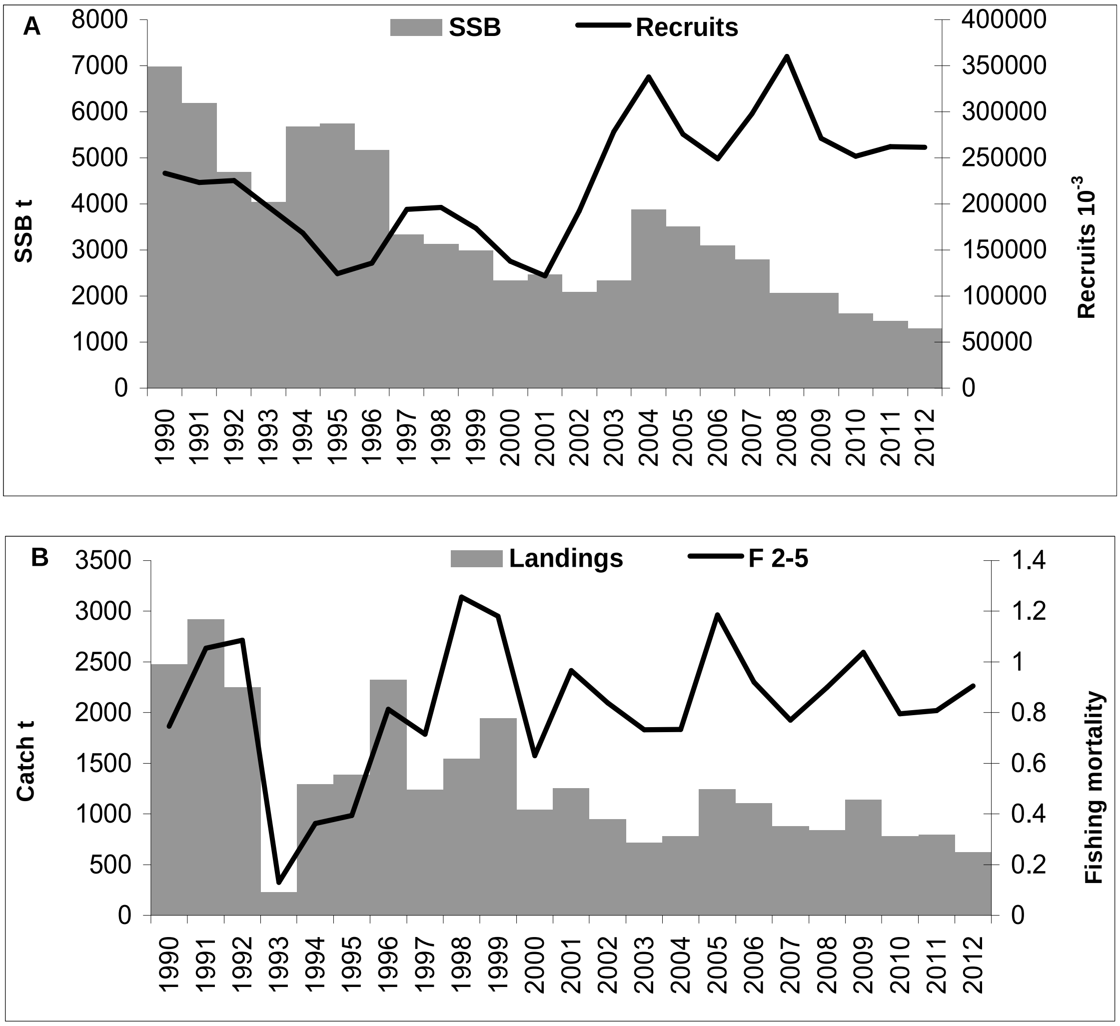


Figure 6.7.4.1.3.3. Summary of the Population estimates from the XSA

The summary of the population estimates from the XSA is presented in Fig 6.7.4.1.3.3. The SSB follows a consistent downward trend with periodic increases due to good recruitment (in 1994-1996 and 2004-2007). Estimates of recruitment are rather imprecise due to the lack of survey data. The present level of recruitment is assessed as relatively high, following a period of peak recruitment in 2004-2008. Fishing mortality is consistently high: 0.8 - 1 except in 1993 when the catch dropped suddenly about 10 time compared to the previous years.

Detailed assessment results are presented in the Table bellow.

Table 6.7.4.1.3.3 XSA results of Red mullet in the Black Sea.

Run title :Red mullet 2012

At 3/10/2013 16:44

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1990,	1991,	1992,
AGE			
0,	.0356,	.0628,	.0412,
1,	.1867,	.2205,	.2936,
2,	.3168,	.6092,	.4896,
3,	.4936,	.7802,	1.1062,
4,	1.6310,	2.0634,	1.9504,
5,	.5441,	.7657,	.7957,
+gp,	.5441,	.7657,	.7957,
0 FBAR 0- 5,	.5346,	.7503,	.7795,

Table 8 Fishing mortality (F) at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	.0022,	.0168,	.0386,	.0678,	.0234,	.0204,	.0084,	.0057,	.0149,	.0133,
1,	.0140,	.1382,	.1578,	.3160,	.1659,	.2903,	.7472,	.3785,	.5170,	.2669,
2,	.0394,	.1867,	.2122,	.4684,	.3988,	.6680,	1.0656,	.7925,	.6042,	.6311,
3,	.0692,	.3019,	.2396,	.6202,	.4835,	1.0827,	1.1908,	.5453,	1.0876,	1.2541,
4,	.3214,	.6878,	.8256,	1.5449,	1.4608,	2.3666,	1.5329,	.6882,	1.4219,	.8521,
5,	.0902,	.2705,	.2996,	.6171,	.5170,	.9091,	.9334,	.4919,	.7470,	.6171,
+gp,	.0902,	.2705,	.2996,	.6171,	.5170,	.9091,	.9334,	.4919,	.7470,	.6171,
0 FBAR 0- 5,	.0894,	.2670,	.2956,	.6057,	.5082,	.8895,	.9131,	.4837,	.7321,	.6058,

1

Run title : mullet 2012

At 3/10/2013 16:44

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	FBAR **-**
AGE											
0,	.0070,	.0095,	.0091,	.0083,	.0073,	.0231,	.0870,	.0399,	.0894,	.0506,	.0600,
1,	.1191,	.1016,	.1895,	.1931,	.1703,	.3022,	.6249,	.5277,	.7315,	.4905,	.5832,
2,	.3796,	.1914,	.4838,	.4843,	.4234,	.6617,	1.0521,	.8000,	.9655,	.8180,	.8612,
3,	1.6315,	.9842,	1.4181,	1.4275,	1.2027,	1.3423,	.8219,	1.0852,	.4458,	1.0298,	.8536,
4,	.3994,	1.2330,	1.9837,	1.0969,	.8919,	.9195,	1.4333,	.6464,	1.1190,	1.0538,	.9397,
5,	.5179,	.5249,	.8566,	.6710,	.5620,	.6792,	.8428,	.6475,	.7009,	.7203,	.6896,
+gp,	.5179,	.5249,	.8566,	.6710,	.5620,	.6792,	.8428,	.6475,	.7009,	.7203,	
0 FBAR 0- 5,	.5091,	.5074,	.8235,	.6469,	.5429,	.6547,	.8103,	.6245,	.6753,	.6938,	

1

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1990,	1991,	1992,
AGE			
0,	233469,	223274,	225269,
1,	158715,	145102,	135049,
2,	102501,	84808,	74961,
3,	51823,	48090,	29702,
4,	21616,	20374,	14194,

5,	4068,	2725,	1667,
+gp,	1173,	928,	508,
0 TOTAL,	573365,	525301,	481350,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	196888,	168236,	124433,	135824,	194210,	196191,	173453,	137680,	121741,	192499,
1,	139224,	126518,	106545,	77109,	81740,	122190,	123809,	110774,	88170,	77244,
2,	64846,	88423,	70965,	58600,	36206,	44594,	58866,	37770,	48859,	33861,
3,	29588,	40151,	47248,	36965,	23625,	15650,	14725,	13061,	11012,	17197,
4,	6328,	17782,	19120,	23947,	12804,	9382,	3414,	2883,	4876,	2390,
5,	1300,	2955,	5757,	5393,	3290,	1914,	567,	475,	933,	758,
+gp,	728,	1090,	893,	1255,	640,	351,	61,	50,	151,	811,
0 TOTAL,	438902,	445155,	374962,	339093,	352516,	390272,	374895,	302693,	275742,	324760,

1

Run title : mullet 2012

At 3/10/2013 16:44

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	2013,	GMST 90-**	AMST 90-**
AGE													
0,	278478,	337916,	275585,	249009,	297800,	360194,	271033,	251696,	262263,	234317,	0,	211259,	221185,
1,	122337,	178106,	161310,	131607,	119004,	142472,	169622,	119725,	116547,	115576,	107351,	122157,	125542,
2,	38094,	69941,	77541,	64317,	52284,	48368,	50752,	43758,	34040,	27026,	34103,	56779,	59539,
3,	11601,	16785,	27834,	23034,	19098,	16498,	12027,	8541,	9475,	6247,	5748,	21361,	24488,
4,	3160,	1462,	3023,	3248,	2663,	2765,	2077,	2548,	1390,	2924,	1075,	5713,	8574,
5,	657,	1365,	205,	200,	523,	526,	531,	239,	643,	219,	491,	1060,	1717,
+gp,	705,	1294,	384,	380,	621,	459,	139,	3,	241,	3,	52,		
0 TOTAL,	455033,	606869,	545883,	471795,	491992,	571282,	506182,	426508,	424601,	386312,	148820,		

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1990,	1991,	1992,
AGE			
0,	0,	0,	0,
1,	1171,	1071,	997,
2,	2034,	1683,	1487,
3,	2068,	1919,	1185,
4,	1293,	1218,	849,
5,	310,	208,	127,
+gp,	110,	87,	47,
0 TOTSPBIO,	6985,	6185,	4692,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	1027,	934,	786,	569,	603,	953,	966,	864,	688,	593,
2,	1287,	1754,	1408,	1163,	718,	938,	1239,	795,	1028,	626,
3,	1181,	1602,	1885,	1475,	943,	596,	561,	498,	420,	612,
4,	378,	1063,	1143,	1432,	766,	484,	176,	149,	252,	138,
5,	99,	225,	439,	411,	251,	134,	40,	33,	65,	55,
+gp,	68,	102,	83,	117,	60,	23,	4,	3,	10,	64,
0 TOTSPBIO,	4040,	5681,	5746,	5167,	3341,	3128,	2985,	2342,	2462,	2088,

1

Run title : mullet 2012

At 3/10/2013 16:44

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	940,	1539,	1084,	892,	914,	752,	896,	632,	615,	610,

2,	704,	1382,	1334,	1158,	966,	689,	723,	641,	487,	374,
3,	413,	653,	896,	822,	680,	445,	325,	238,	244,	171,
4,	182,	95,	151,	186,	153,	108,	81,	96,	54,	120,
5,	48,	100,	15,	14,	38,	30,	31,	13,	36,	14,
+gp,	55,	102,	30,	28,	49,	40,	12,	0,	21,	0,
0 TOTSPBIO,	2342,	3872,	3510,	3100,	2800,	2065,	2067,	1620,	1459,	1289,

1

Run title : mullet 2012

At 3/10/2013 16:44

Terminal Fs derived using XSA (With F shrinkage)

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1990,	1991,	1992,
AGE			
0,	1144,	1094,	1104,
1,	1952,	1784,	1661,
2,	2542,	2103,	1859,
3,	2068,	1918,	1185,
4,	1293,	1218,	849,
5,	310,	208,	127,
+gp,	110,	87,	47,
0 TOTALBIO,	9418,	8413,	6833,

Table 17 Summary (with SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 0- 5,
1990,	233469,	9418,	6985,	2476,	.3545,	1.0000,	.5346,
1991,	223274,	8413,	6184,	2922,	.4725,	.9999,	.7503,
1992,	225269,	6833,	4693,	2251,	.4797,	1.0000,	.7795,
1993,	196888,	6011,	4040,	229,	.0567,	.9998,	.0894,
1994,	168236,	7566,	5681,	1294,	.2278,	1.0000,	.2670,
1995,	124433,	7231,	5745,	1389,	.2418,	.9999,	.2956,
1996,	135824,	6502,	5167,	2325,	.4500,	.9999,	.6057,
1997,	194210,	4874,	3340,	1241,	.3715,	.9999,	.5082,
1998,	196191,	5135,	3128,	1542,	.4930,	.9998,	.8895,
1999,	173453,	4941,	2983,	1945,	.6521,	.9992,	.9131,
2000,	137680,	3912,	2340,	1042,	.4453,	.9993,	.4837,
2001,	121741,	3881,	2461,	1255,	.5100,	.9995,	.7321,
2002,	192499,	3521,	2085,	947,	.4542,	.9988,	.6058,
2003,	278478,	4419,	2339,	719,	.3075,	.9987,	.5091,
2004,	337916,	7335,	3870,	784,	.2026,	.9995,	.5074,
2005,	275585,	5387,	3506,	1245,	.3551,	.9989,	.8235,
2006,	249009,	4732,	3100,	1106,	.3567,	1.0000,	.6469,
2007,	297800,	5017,	2798,	881,	.3149,	.9992,	.5429,
2008,	360194,	4148,	2067,	838,	.4054,	1.0011,	.6547,
2009,	271033,	3907,	2070,	1139,	.5502,	1.0014,	.8103,
2010,	251696,	3213,	1622,	780,	.4808,	1.0015,	.6245,
2011,	262263,	2958,	1457,	795,	.5455,	.9990,	.6753,
2012,	234317,	2728,	1290,	623,	.4830,	1.0006,	.6938,
Arith. Mean ,	223542,	5308,	3433,	1294,	.4005		.6062,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

6.7.5 *Short term predictions of stock biomass and catch*

6.7.5.1 Justification

A deterministic short term prediction of stock size and catch was conducted based on XSA results.

6.7.5.2 Input parameters

The input parameters are listed in the Table below. They do represent short term averages of the XSA inputs. The exploitation pattern used is the 2012 estimated vector rescaled to the average exploitation patterns estimated for the years 2009-2011. Due to the lack of recruitment index. recruitment was estimated using the geometric mean from 2009-2011.

As the fishery for red mullet in the Black Sea is not constrained by an international TAC. the year 2012 was defined as a *status quo* effort year with unchanged fishing mortality.

Table 6.7.5.2.1. Red Mullet in the Black Sea. Input to short term prediction.

2013						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	261544	0.7300	0.0000	0.004	0.0649	0.004
1	118115	0.7300	0.6000	0.0088	0.6317	0.0088
2	29614	0.7300	0.8000	0.0173	0.9327	0.0173
3	5125	0.7300	1.0000	0.0274	0.9245	0.0274
4	1194	0.7300	1.0000	0.0409	1.0178	0.0409
5	509	0.7300	1.0000	0.0634	0.7469	0.0634
6	50	0.7300	1.0000	0.0866	0.7469	0.0866
2014						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	261544	0.7300	0.0000	0.004	0.0649	0.004
1		0.7300	0.6000	0.0088	0.6317	0.0088
2		0.7300	0.8000	0.0173	0.9327	0.0173
3		0.7300	1.0000	0.0274	0.9245	0.0274
4		0.7300	1.0000	0.0409	1.0178	0.0409
5		0.7300	1.0000	0.0634	0.7469	0.0634
6		0.7300	1.0000	0.0866	0.7469	0.0866
2015						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	261544	0.7300	0.0000	0.004	0.0649	0.004
1		0.7300	0.6000	0.0088	0.6317	0.0088
2		0.7300	0.8000	0.0173	0.9327	0.0173
3		0.7300	1.0000	0.0274	0.9245	0.0274
4		0.7300	1.0000	0.0409	1.0178	0.0409
5		0.7300	1.0000	0.0634	0.7469	0.0634
6		0.7300	1.0000	0.0866	0.7469	0.0866

6.7.5.3 Results

The *status quo* fishing in 2013 would result in landings 740 t and SSB of 1259 t. Thus the forecasted 2013 SSB is very close to the already quite low SSB in the current year. It is expected to stay unchanged in the next couple of years under *status quo* fishing.

Estimates of recruitment are rather imprecise due to the lack of survey data. The present level of recruitment equal of 261544 was estimated a geometric mean over 2009-2011. It is assessed as relatively high, following a period of peak recruitment in 2004-2008.

Total catches have been gradually decreasing since 1996 under a consistently high fishing pressure due mainly to the Turkish fishery. Under the status quo F assumption, catches are expected to remain low (around 740) in 2013 - 2015.

More management options through multiplications of the fishing mortality are given in Table 6.7.5.3.1. The Fmsy level of fishing mortality of 0.46 (F0.1 as a Fmsy proxy) would initially reduce the catches to 467 t in 2014, but in 2015 the catch is expected to rise up to 556t.

The EWG 13-12 believes that exploitation should be kept bellow the level of Fmsy.

Table 6.7.5.3.1.Red Mullet in the Black Sea. Single option (status quo) short term prediction.

2013	F-factor:	1	reference F2-5	0.9055		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0649	11718	47	261544.2462	1046	0	0
1	0.6317	40754	359	118114.5156	1039	70869	624
2	0.9327	13462	233	29613.7423	512	23691	410
3	0.9245	2316	63	5124.765877	140	5125	140
4	1.0178	574	23	1194.326166	49	1194	49
5	0.7469	199	13	509.2296619	32	509	32
6	0.7469	20	2	50	4	50	4
		69043	740	416151	2822	101438	1259

2014	F-factor:	1	reference F2-5	0.9055		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0649	11718	47	261544	1046	0	0
1	0.6317	40754	359	118115	1039	70869	624
2	0.9327	13758	238	30264	524	24211	419
3	0.9245	2538	70	5615	154	5615	154
4	1.0178	471	19	980	40	980	40
5	0.7469	81	5	208	13	208	13
6	0.7469	45	4	116	10	116	10
		69365	742	416853	2826	102010	1260

2015	F-factor:	1	reference F2-5	0.9055		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0649	11718	47	261544	1046	0	0
1	0.6317	40754	359	118114	1039	70868	624
2	0.9327	13758	238	30264	524	24211	419
3	0.9245	2594	71	5739	157	5739	157
4	1.0178	516	21	1073	44	1073	44
5	0.7469	67	4	171	11	171	11
6	0.7469	18	2	47	4	47	4
		69425	742	416983	2825	102140	1259

Table 6.7.5.3.2.Red Mullet in the Black Sea. Management option table providing short term prediction.

		2013					2014				2015	
F-factor	reference F	stock biomas	sp. stock bion	catch in weigl	F-factor	reference F	stock biomas	sp. stock bion	catch in weigl	stock biomas	sp. stock bion	catch
1.0000	0.9055	2822	1259	740	0.0000	0.0000	2826	1260	0	3691	2004	0
					0.1000	0.0830	2826	1260	98	3573	1902	143
					0.2000	0.1659	2826	1260	188	3464	1806	264
					0.3000	0.2489	2826	1260	273	3364	1720	366
					0.4000	0.3507	2826	1260	352	3269	1637	452
					0.5500	0.4822	2826	1260	464	3141	1528	554
					0.6000	0.5260	2826	1260	498	3101	1493	581
					0.7000	0.5807	2826	1260	565	3025	1428	634
					0.8000	0.6637	2826	1260	628	2953	1367	677
					0.9000	0.7467	2826	1260	687	2887	1311	712
				Fsq	**1.0000**	**0.8296**	**2826**	**1260**	**742**	**2825**	**1259**	**742**
					1.1000	0.9126	2826	1260	793	2768	1210	766
					1.2000	0.9956	2826	1260	843	2712	1164	788
					1.3000	1.0785	2826	1260	890	2661	1122	805
					1.4000	1.1615	2826	1260	932	2614	1081	819
					1.5000	1.2445	2826	1260	974	2571	1046	830
				Fmsy	**0.554**	**0.460**	**2826**	**1260**	**467**	**3137**	**1524**	**556**

6.7.6 *Medium term prediction of stock biomass and catch*

The current state of the assessment does not allow any reliable formulation of a medium term prediction of stock size and biomass under various management scenarios.

6.7.7 *Long term predictions*

6.7.7.1 Input parameters

Table 6.7.7.1.1 represents the input parameters to the YPR analysis. They are derived from long term means of the XSA input data (2000-2012) except the exploitation pattern, which was estimated as the 2012 exploitation pattern rescaled to the average of the years 2009-2011.

Table 6.7.7.1.1Red Mullet in the Black Sea. Input parameters to YPR analysis.

age min	age group	stock weight	catch weight	maturity	F	M
0	0	0.0046913	0.0046913	0	0.0649	0.55
age max	1	0.01172609	0.01172609	0.6	0.6317	0.55
6	2	0.02307391	0.02307391	0.8	0.9327	0.55
Fref	3	0.03566522	0.03566522	1	0.9245	0.55
0.9055	4	0.0533	0.0533	1	1.0178	0.55
	5	0.0702	0.0702	1	0.7469	0.55
	6	0.08305217	0.08305217	1	0.7469	0.55

6.7.7.2 Results

YRR analyses yielded estimates of Fmax=1.41 and $F_{0.1}$=0.46. The EWG endorsed $F_{0.1}$=0.46 as a Fmsy proxy.

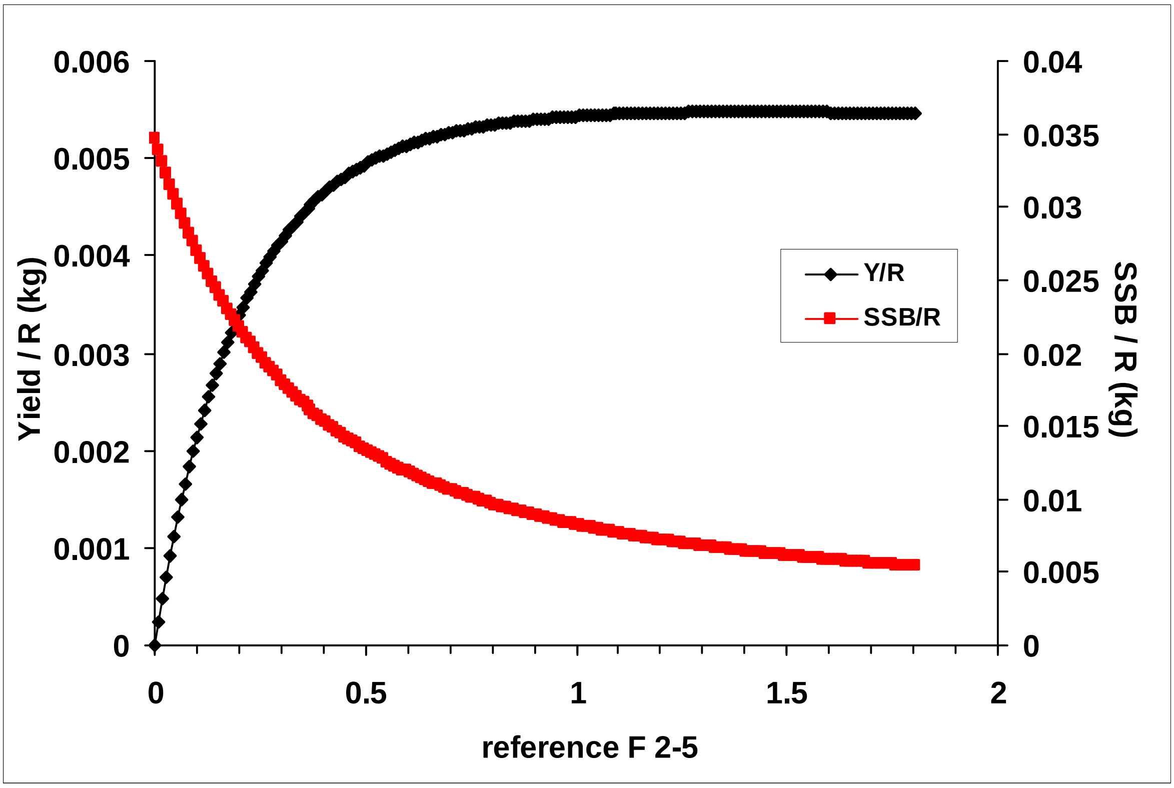


Fig. 6.7.7.2.1 Red Mullet in the Black Sea. YpR and SSBpR with increasing fishing mortality (average of ages 2-5).

6.7.8 *Scientific advice*

The lack of a fishery independent scientific survey to monitor red mullet all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. The EWG 13- 12 recommends such survey to be established.

6.7.8.1 Short term considerations

State of the spawning stock size:

The EWG has accepted the XSA assessment, considers both catch at age and survey data as rather meagre and needing a better quality data in future. The SSB follows a consistent downward trend with periodic increases due to good recruitment (in 1994-1996 and 2004-2007). During the 1990s the SSB of the range of 5000 - 6000 t in the recent years it has dropped to about 1500-2000t. SSB in 2012 is estimated at 1289 t.

State of recruitment:

Estimates of recruitment are rather imprecise due to the lack of survey data. The present level of recruitment, estimated as a geometric mean over 2009-2011, is assessed as relatively high, following a period of peak recruitment in 2004-2008.

State of exploitation:

Total catches have been gradually decreasing since 1996 under a consistently high fishing pressure due mainly to the Turkish fishery. Fishing mortality has been assessed as consistently high F= 0.8 - 1 since 1990 and above the Fmsy=0.46 level.

Under the status quo F assumption, catches are expected to remain low (around 740) in 2013 - 2015. under Fmsy fishing catches are expected to reachlevels of 467-556t.

The EWG 13-12 suggests that exploitation should be kept below the level of Fmsy.

6.7.8.2 Medium term considerations

EWG 13-12suggest that exploitation should be kept bellow the Fmsy referenec level in order to enable the rebuilding of the stock.

6.8 Atlantic Bonito in the Black Sea

6.8.1 *Biological features*

6.8.1.1 Stock Identification

Bonito plays a major role as top predator in the Black Sea ecosystem and has high commercial importance, especially for the Turkish fishery. While total catches of bonito from all Black Sea coastal states reached the maximum of 20.000 tons in 1969, thereafter have no bonito catches recorded from these countries, except Turkey and Bulgaria. This was mainly due to pollution in northwest Black Sea, problems with migration routes (changing of oceanographic conditions) and heavy fishing impact occurred in the Black Sea on bonito stocks.

Reports of last 25 years have shown that a dominant part of the bonito catches in the Black Sea, have are obtained in Turkish waters (BSEP, 2003; Prodanov et al., 1997). However, when considering the long-term statistics, Turkey's bonito catch from the Black Sea was also subjected to important fluctuations. There has been a decrease in catches since 2002. In 2005 an exceptional catch was landed - 70 797 t. In 2006, the catch decreased to 29 690 t. The 2005 catch was the highest in the last 35 years. It may be caused by some oceanographic factors and climate changes observed in the early 2000s such as:

- While egg hatched, pre larva, post larva and juvenile periods getting to increase, which cause the decrease in natural mortality rate. The favorable water temperature and alterations in pelagic food web have positive effect on bonito population.
- The spawning period may be prolonged compared to the period before 2000.
- Migrating population into Black Sea spend more time than before and feed on small pelagic species as anchovy, horse mackerel and sprat.

6.8.1.1.1 *Feeding and spawning migration*

Bonito population starts to migrate for reproduction and feeding from the end of April to August from the Aegean Sea to the Sea of Marmara and the Black Sea (Figure 6.8.1.1.1.1). The back migration start from September to December through the Bosphorus and Marmara Sea to the Aegean Sea. The most intensive migration occurs in November and December. During the winter, bonito hibernates in the Marmara Sea (Kutaygil, 1979). Studies conducted over the bonito catches during autumn/winter migration in the southern Black Sea coasts showed the evidence that while a stock of bonito was migrating, a small part of bonito remained in the Black Sea (Nümann, 1954). Bonito migration in the Black Sea is mainly governed by biological and oceanographic conditions (Demir, 1961). Bonito spawns from the end of May until the mid July in the most northern parts of the Black Sea (Demir, 1957). It was reported that the optimum water temperature for spawning is 18.0 (13.9-23.1) ^{0}C (Majorova and Tkacheva, 1960).

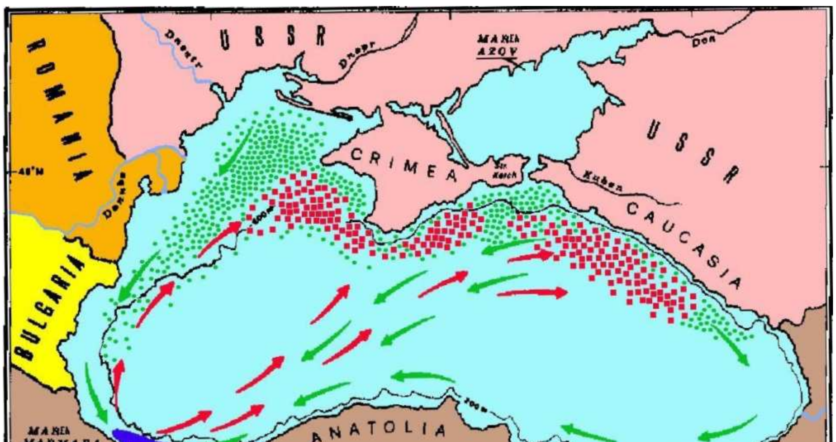


Figure 6.8.1.1.1.1. Map of distribution and migrations of bonito in the Black Sea

6.8.1.1.2*Population parameters*

The analysis of catch composition of landings during the fishing seasons of 2000/01 and 2001/2 showed that the length distributions of bonito are between 15.5-46.0 (28.1±2.61, n=492) and 15.1-47.5 (31.2±3.33) cm (total length) respectively. Through the examination of length distribution, it was noticed that the length groups were formed in such a way that there were two distinct pick points. The average length values for these points were computed to be 26.4± 3.68 and 35.4± 3.57 cm. Each of these pick points referred to a year class group (Zengin and Dinçer, 2006). Bonito landed catch also have been sampled fishing season September, October, November) in the Eastern Black Sea in 2006. The average total length was found 31.42 cm and the size range was between 21.9 and 44.0 cm. The average weight was 339.33 g with a weight distribution between 89.52 and 940.70 g (Genç et. al., 2006).

Bonito population generally reaches the sexual maturity at two years of age. Maturity differences observed even within the individuals of same year class and as well as the variations occurred in water temperatures caused the spawning time to spread in a rather longer period. It was noticed that for all months, in which the sampling took place, there new individuals zero (0) age to join the stock (Zengin and Dinçer, 2006).

Bonito populations migrating along the Black Sea coasts during the autumn/winter season consists of zero and one year's old individuals. The main lengths computed from these age groups were agreed by previous studies carried out in the Black Sea. Nümann (1954) and Türgan (Artüz, 1957) showed that the length ranges for bonito populations according to the age groups were 38-42 cm at the and of first year, 53-57 cm at the end of second year and 60-65 cm at the and of third year in the northern Black Sea part. The mean length were reported to be 37.7 cm for 1 year of age, 50.6 cm for 2 years of age, 59.8 cm for 3 years of age and 65.5 cm for 4 years of age. (Majorova and Tkacheva, 1960). For the Bulgarian coasts, the mean lengths for age groups of 0^+, 1^+ and 2^+ were found to be 25.0 cm, 39.3 cm and 53.0 cm respectively (BSEP, 2003).

The bonito reaches the first sexual maturity length at the end of its first year and at the beginning of its second years (Ivanov and Beverton, 1985). It is therefore, possible to say that almost whole bonito population being in southern Black Sea coasts during the autumn/winter migration was composed of individuals that did not reach sexual maturity yet. The fact that such individuals hardly exited in population pattern. It was pointed out by Kutaygil (1979) that the bonito populations have tendency to form shoals by being composed of the individuals of the same year.

6.8.1.2 Growth

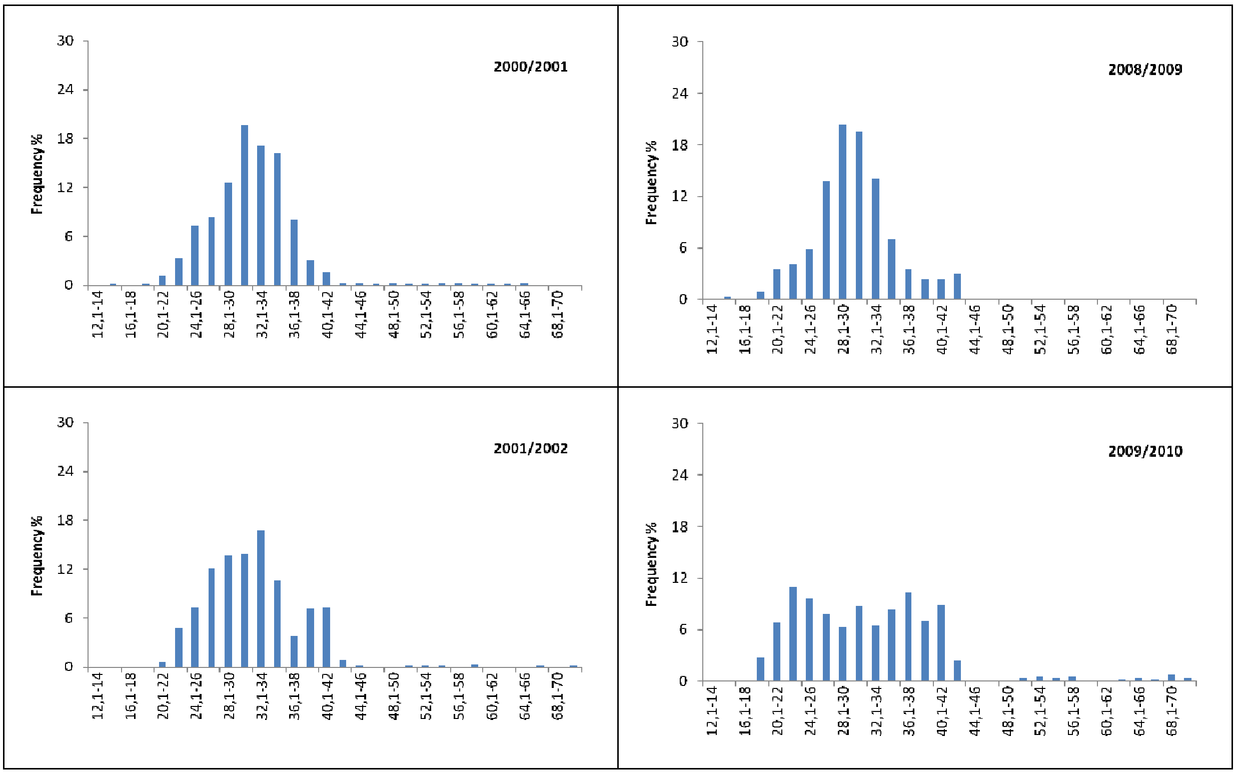
A total of 6433 individuals were collected between 2000 and October 2012 using market, purse seine and gill nets off the Turkey coast of Black Sea.

The species is fast growing; age comprises 0-3 age groups. Minimum and maximum of the von Bertalanffy growth parameters were computed as $L\infty$ = 65.90 and 99.70 cm, k = 0.34 and 1.19 year^{-1}, $t0$ = –0.17- -0.38 years for all fish between 2000 and 2012 fisheries season. The von Bertlanffy Growth Parameters VBGF by Turkey is given in Table 6.8.1.2.1.

Table 6.8.1.2.1. VBGF parameters calculated in the Turkey coast of Black Sea

Age	2000	2001	2005	2006	2007	2008	2009	2010	2011	2012
k	0.76	0.39	0.57	0.71	0.68	0.70	0.34	0.72	1.19	0.92
Loo	72.89	95.26	77.00	73.64	82.55	73.87	99.70	73.62	65.90	72.60
to	-0.23	-0.34	-0.29	-0.25	-0.23	-0.25	-0.38	-0.25	-0.17	-0.20
a	0.0044	0.0034	0.0027	0.0034	0.0037	0.0063	0.0021	0.0038	0.0038	0.0037
b	3.3282	3.3607	3.3871	3.3109	3.2831	3.2040	3.4464	3.2705	3.2873	3.2806
M	0.718	0.43	0.586	0.685	0.645	0.678	0.388	0.691	0.99	0.814

Atlantic Bonito has lengths comprised between 13 and 72cm. the highest frequency pertaining to the individuals of 30-40cm lengths (Figure 6.8.1.2.1). It has weights comprised between 15.8 and 5800g. The most of population has formed 0^{+} age groups. Rate of 1-3 age groups is decreased according to 0+ ages.



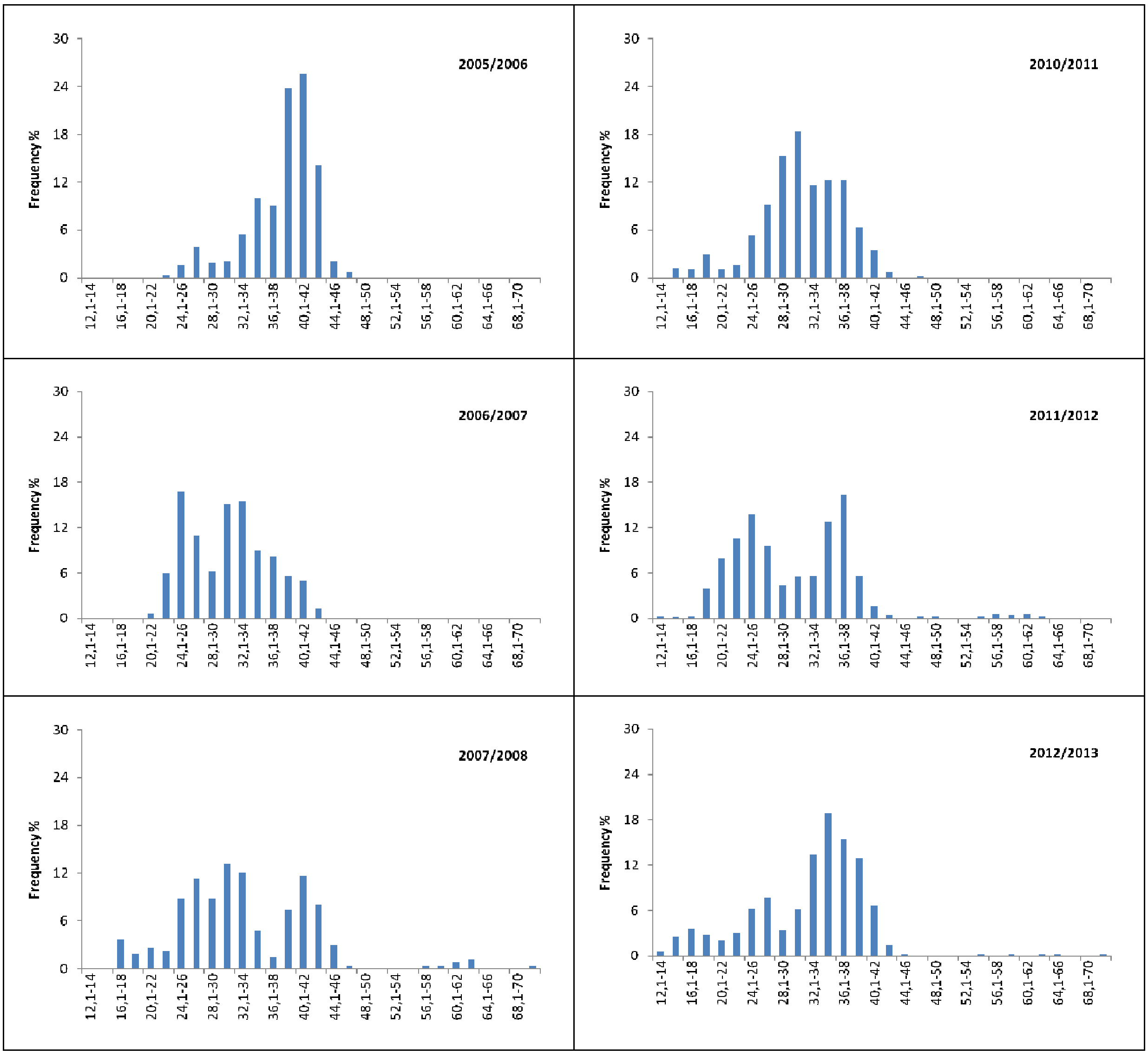


Figure. 6.8.1.2.1. Length distributions of bonito in the catch from the Turkey waters of the Black Sea

According to Figure 6.8.1.2.2., length classes from 2001 and 2012 are similar as the largest specimen over 45 cm was presented in the catch with low percent.

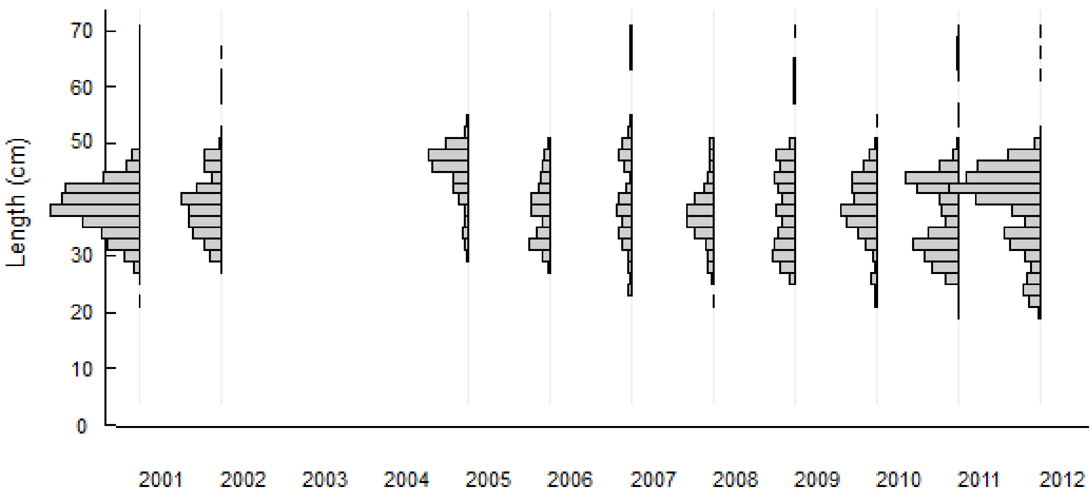


Figure 6.8.1.2.2. Growth curve of Atlantic bonito from Turkey Black Sea waters between 2001-2012 years

The length and weight frequency distributions (for Turkish waters) were presented in Figure 6.8.1.2.3.Age distribution ranged from 0 to 3 years. Year class 0 (70.61%) was dominant, followed by year classes I (28.25%), II (0.82%), and III (0.32%).

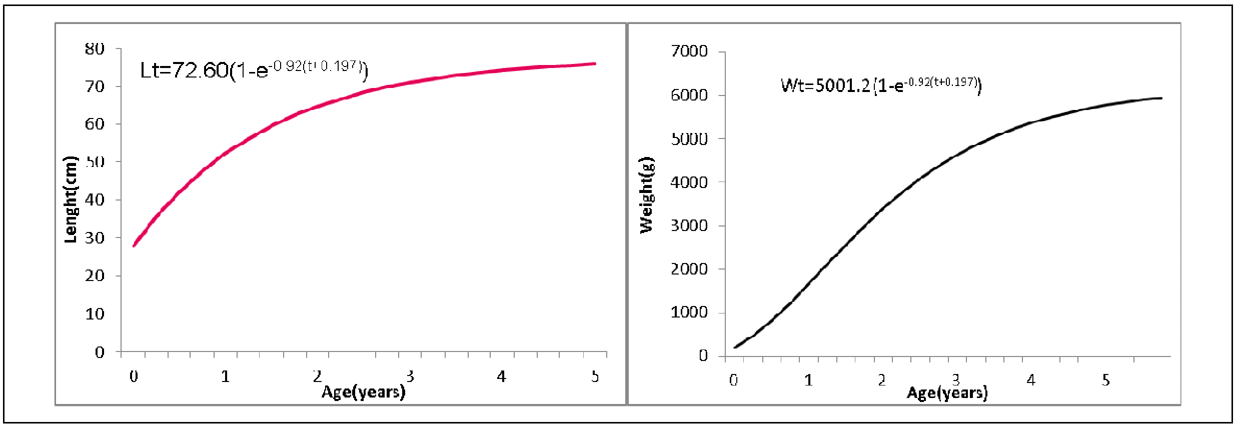
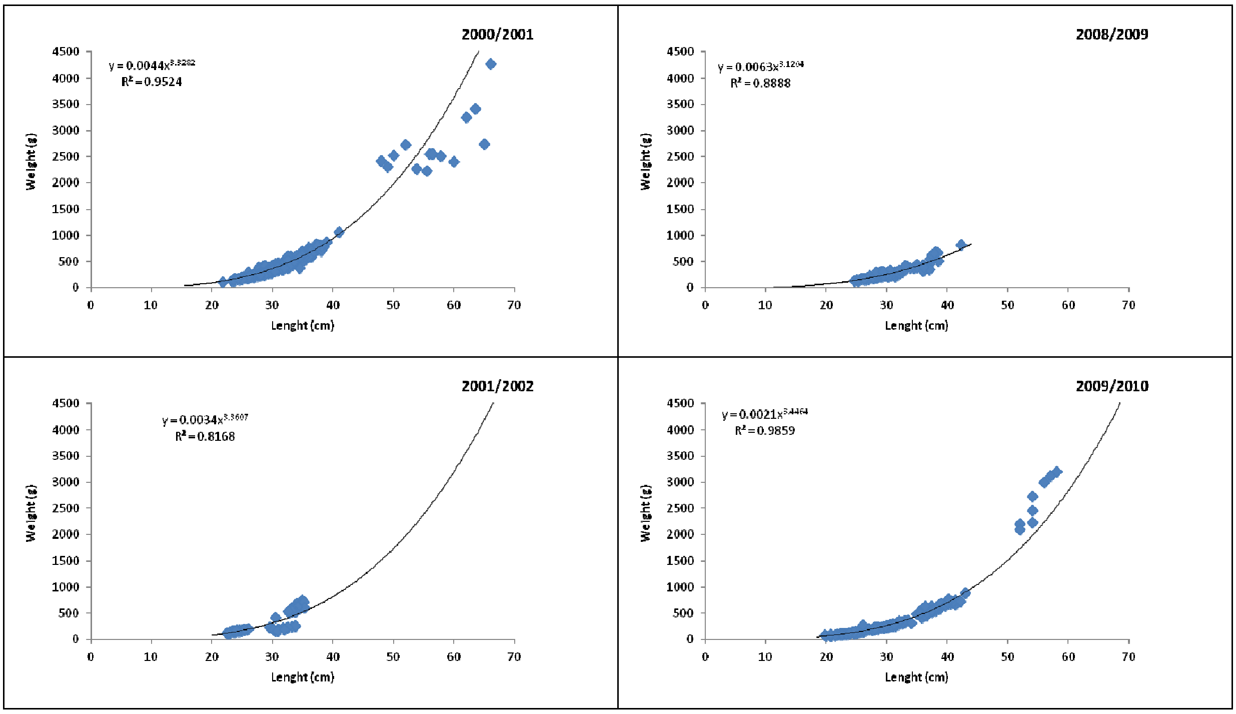


Figure 6.8.1.2.3. The age-length relationship in Atlantic bonito for Turkish waters of the Black Sea, 2011-2012 Fisheries Season

The length–weight relationship was estimated for all years (Figure 6.8.1.2.4.). While the *b*-values and t-test results indicated positive allometric growth for all samples, the *b*-values showed no significant difference for years (P > 0.05).



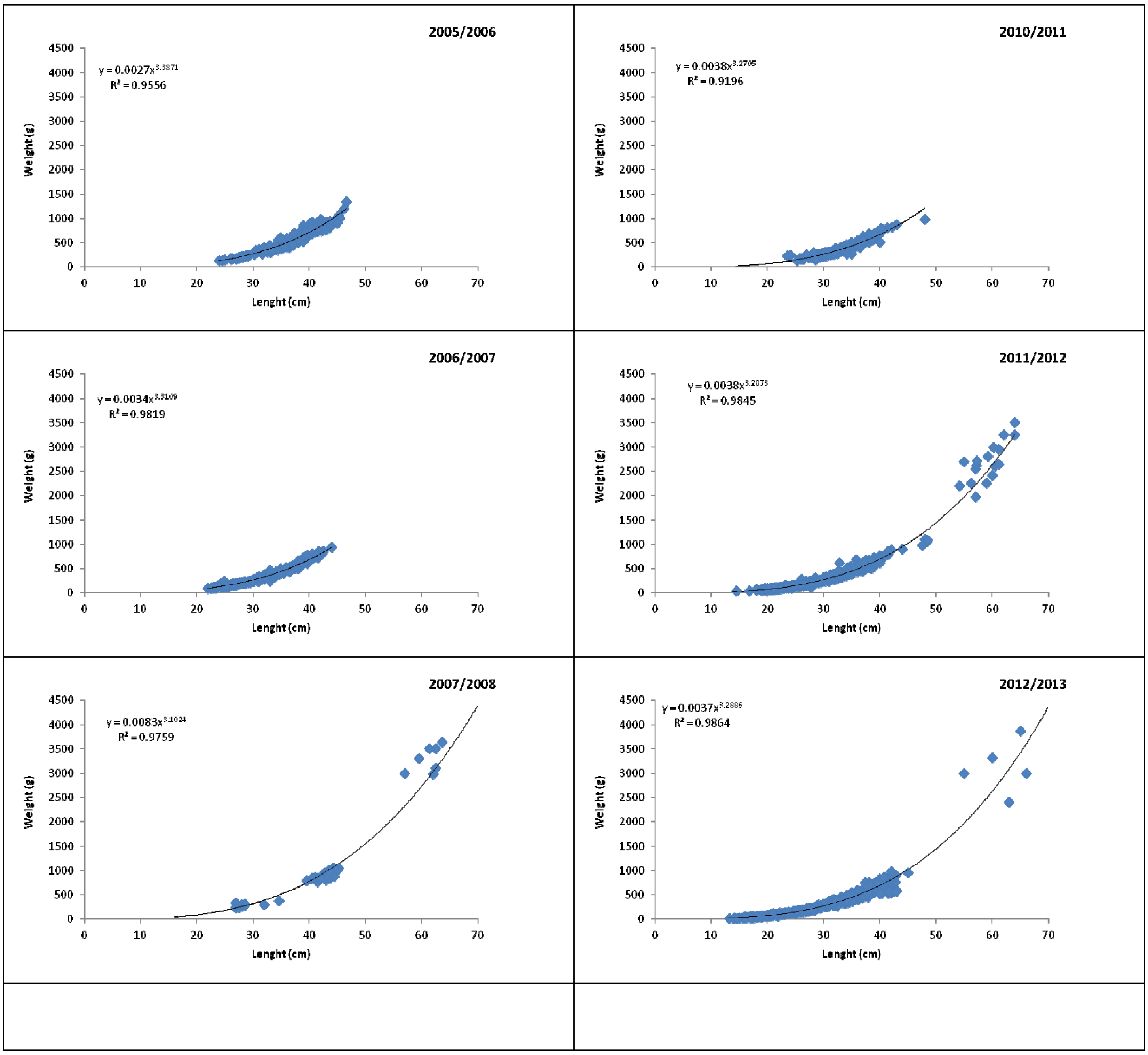


Figure 6.8.1.2.4. The length-weight relationship in Atlantic bonito for Turkish waters of the Black Sea, all Fisheries Season

6.8.1.3 Maturity

No maturity studies were conducted in all years.

6.8.2 *Fisheries*

6.8.2.1 General description

Fishing activity for bonito takes place in the Black Sea generally within August and February, and reaches highest level in September and October. The earliest and the latest dates for the bonito catch were recorded to be 29 July and the March, respectively.

It was seen that the majority of bonito catch (84.6%) were taken by Turkish purse seines, of which the maximum vessel length and power were 48 m and 1600 HP respectively. It was noticed that in purse seine fishing the seines could chase bonito shoals as far as 32 km from the shore. For the September, October and November in which the bonito fishing is most dense, the values of CPUE were 818.3, 601.7 and 156.5 kg/operation (Zengin and Dinçer, 2006).

It was found that the bonito catch taken by Turkish fisherman by surface gill-nets from the Black Sea amounted about 15.4% of the total catch. In this fishing category, the vessel used is made of wood and is generally of 8.9 (6.3-13.8) m lengths and 44.8 (8-15) HP. Depending on the weather conditions, daily average operation number is found to be 2 (1-6) and the average active fishing time for the gear in the sea is 3.1 (0.8-7.0) hours. It was observed that fishing operations started from the beginning of sunset and continued over the night between the hours of 18:00-24:00 being the most intensive. The CPUE values for this gillnets were found to be close to each other for September, October and November. The average value for the CPUE is 83.1 (0.6-967) kg/operation (Zengin and Dinçer, 2006).

Quantitative stock assessment of bonito has not been performed and can be quite challenging. Main data consist of landings (from different areas), biological information (size, age, maturity) and commercial CPUE. The fact that bonito is fast growing and 0+ and 1 year old individuals are clearly dominant in the catches make the total landing a quite good indicator of the relative stock size. Age or size structured population models can be applied to estimate historical and current stock parameters.

6.8.2.2 Management Regulations

Sarda sarda fisheries in Turkey is regulationed by the Commercial Fishery Advice of General Directorate of Fishery (Anonymous, 2012).

(1) **Regulations about Fishing area:** For purse seines, it is not allowed in the waters shallower under the 24 m (from the coastal).

(2) **Regulations about fishing gear:** The depth of purse seine net can not be more than 164 m.

(3) **Regulations about time periods:** Fishing period of purse seine is between 1 September and 15 April.

6.8.2.3 Catches

6.8.2.3.1*Landings*

Total quantities can be relevant, like in 2005, when the total production in Turkey Black Sea reached a peak of more than 64.000 tons. In Turkey, the declared landings of Atlantic bonito in the last years are the following: 6322 tons in 2010; 6726 tons in 2011; 29854 tons in 2012 (Figure 6.8.5.1).

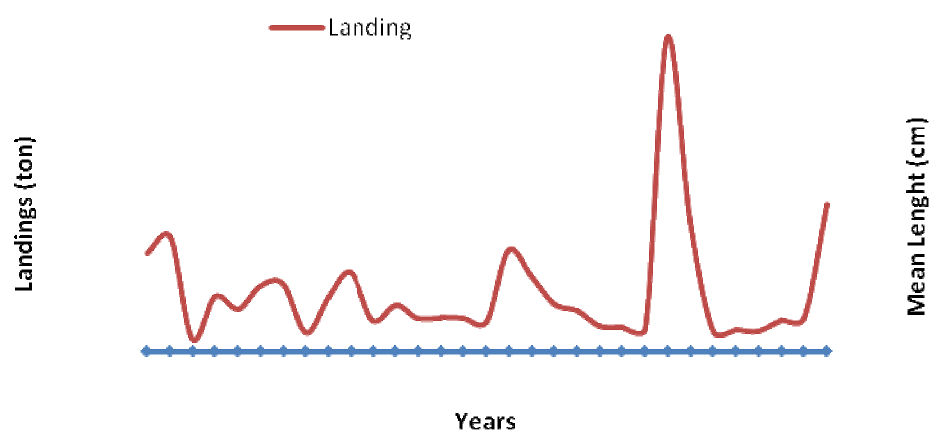


Figure 6.8.5.1. Distribution of landing and average length of Atlantic bonito Turkey coast of Black Sea time series data

Landings of the red mullet in the Black Sea were reported by the Turkey (Table 6.8.5.1.) Landings significantly decreased by fluctuations in the last 15 years in Turkish data.

Table 6.8.5.1.According to landing of Atlantic bonito Turkey coast of Black Sea

Years	**Eastern Black sea (Turkey)**	**Western Black Sea Turkey)**	**Black Sea(Turkey)**
1982	8.629	11522	20.151
1983	8.701	14668	23.369
1984	664	1938	2.602
1985	7.486	3640	11.126
1986	3.422	5226	8.648
1987	5.287	8026	13.313
1988	5.647	8186	13.833
1989	1.936	1936	3.872
1990	4.057	7199	11.256
1991	7.030	9114	16.144
1992	3.399	2938	6.337
1993	4.248	5213	9.461
1994	2.385	4492	6.877
1995	861	6005	6.866
1996	1.285	5467	6.752
1997	3.362	2682	6.044
1998	12.019	8461	20.480
1999	10.775	4458	15.233
2000	3.084	6653	9.737
2001	2905	5332	8.237
2002	2016	3159	5.175
2003	1924	3015	4.939
2004	1828	2865	4.693
2005	33572	30324	63.896
2006	19090	7373	26.463
2007	2707	1539	4.246
2008	2565	1971	4.536
2009	2535	1681	4.216
2010	3408	2914	6.322
2011	3554.8	3171.2	6.726
2012	14991.1	14862.8	29.854

6.8.2.3.2*Discards*

No discards have been reported for the Atlantic bonito fishery.

6.8.3 *Scientific Surveys*

No specific fisheries independent scientific surveys have been conducted.

6.8.4 *Assessment of historic parameters*

6.8.4.1 Input parameters

Table 6.8.4.1.1. Data availability by country.

Type of data	BG	TR	Selection for Assessment	Comments
Official landings	Yes	1982-2012		
Illegal, Unreported Catch	No	No		
Fishing effort and CPUE	No	2012		
Number of fishing vessels	No	1996-2012		
Research surveys –adult	No	No		
Reserch surveys –juvenile	No	No		
Hydroacoustic surveys	No	No		
Length composition	No	2001-2012		
Weight at length (survey, landings)	No	2001-2012		
Age composition	No	2001-2012		
Weight at age (survey, landings)	No	2001-2012		
Maturity at age	No	No		
Natural mortality	No	Yes		

Availability of Data for assessment

Catch at age

Table 6.8.4.1.2. Aggregated catch at age in number $10^{-3}$of Turkey.

Year	Age-0+	Age-1	Age-2	Age-3
2000	7735.035	9551.772	1323.712	372.0833
2001	8513.704	10741.02	0	3183.519
2002				
2003				
2004				
2005	3364.883	94235.96	0	0
2006	28425.79	49498.43	0	0
2007	230.7439	1489.976	1493.865	374.3538
2008	11507.07	5513	0	0
2009	4044.66	3960.605	2276.431	465.6385
2010	6199.694	10633.11	0	0
2011	4665.997	10457.62	2866.445	497.8718
2012	9842.11	56652.81	1296.113	1382.787

Weight at age in the catch

Table 6.8.4.1.3. Weight at age in the catch (in g).

Year	Age-0+	Age-1	Age-2	Age-3
2000	371.581	612.7929	2632.6	3700
2001	205.7158	562.3243		5000
2002				
2003				
2004				
2005	226.2813	702.1296		
2006	210.3911	524.6252		
2007	275	887.8746	3306.429	5800
2008	218.2993	494.4091		
2009	206.3588	580.5513	2627.75	4300
2010	260.2305	506.4648		
2011	153.7717	544.0284	2594.667	3380
2012	178.7153	542.6042	3240	3456.667

Table 6.8.4.1.4. Atlantic bonito maturity at age.

Age	%Mature	M
0+	0	2.259936
1+	1	0.954501
2+	1	0.743604
3+	1	0.679564

6.9 Rapana in the Black Sea

6.9.1 *Biological features*

6.9.1.1 *Stock Identification*

Rapa (veined)whelk *Rapana venosa (syn. Rapana thomasiana*-mainly used in former USSR*)* was introduced into the Black Sea in the 1940s and spreaded along the Caucasian and Crimean coasts and to the Sea of Azov within a decade. Its range extended into the northwest Black Sea to the coastlines of Romania, Bulgaria and Turkey from 1959 to 1972 (Global Invasive Species Database (http://www.issg.org/database). *R. venosa* is well established in the benthic ecosystem of all Black Sea coastal statesand has exerted significant predatory pressure on theindigenous malacofauna (Black Sea TDA, 2008).

The impact on bivalve populations is variable and ranges fromrather mild along the Romanian coast possibly due to suboptimal environmental condition.moderate in Bulgarian and Turkish Black Sea, and severe along Russian and Ukrainian coasts,where the whelk has been blamed for local exterminations or major declines in the numbers ofother bivalves (Black Sea TDA. 2008).

In the Black Sea, *Rapana venosa* occurs on sandy and hard-bottom substrates to 45 m depth. The highest abundance occurs in the Kerch Strait at the entrance to the Sea of Azov, near Sevastopol and Yalta (Ukraine), and along the Bulgarian coast (ICES, 2004).

After the adaptation in the Black Sea ecosystem, it has formed dynamic stocks along the whole Southern Black Sea Coasts since 1969 (Bilecik, 1974). The whelk population has spread gradually onward to 1970s and also its stock has started increasing in coastal benthic habitats extremely in 1980s. Rapa whelk has established and pressured on the bivalve communities for predation in the shallow waters in the Black Sea coast of Turkey (Bilecik, 1990).

R. venosa is a prolific, extremely versatile species tolerating low salinities, water pollution and oxygen deficient waters.Veined Rapa whelk becomes mature at theage of 2-3 old and has 8-9 years life span.Preferred habitats are shell substrates and shell bottoms with varying degrees of silting, but on the silt beds the Rapa whelk occurrence is not high. The species demands to salinity with the lower limit of its development about 12 ‰ and also to the temperature-at low temperatures the activity of Rapa whelk falls and if the temperature falls to 10° C, the species stop to feed. Local migrations of Rapa whelk have been associated with seasonal changes of water temperature and have been oriented toward the shore in the period of water heating during spring-summer season, and towards to depths in the autumn-winter cooling.Ciuhcin (1984) describes the reproductive period of *R. venosa* in the Black Sea as July to September, corresponding to a temperature window of 19^{o}C to 25^{o}C. Sahin (1997) reports a spawning period of May to November in the eastern Black Sea. Females lay eggs in cocoons attached to the substrate. Each egg capsule contains 200-500 eggs.Pelagiclarvae of sea snail feed on nanoplankton algae and their adults feed mainly on bivalves of familiesCardiidae, Mytilidae, Veneridae, Archidae (GFCM:SAC12/2010).Looking for prey Rapa whelk is able to move on rather large distances. The speed of movement makes up from 5 till 20 cm/min. In some periods of a year it buries itself into the ground.

Introduction of this predatory mollusk into the ecosystem of the Black Sea turned out to be a catastrophe for oyster biocenoses. Distribution of Rapa whelk is associated with reduction of mussel banks in particular near the coasts of Anatolia and Caucasus. In the Ukrainian waters Rapa Whelk destroyed the oyster banks in the area of the Kerch Strait and in Karkinitsky Bay, biocenoses of other mollusks associated with depth down to 30 m suffered as well.

The Turkish investigations concerning biomass distribution of Rapa whelk by depth and season indicates that 76.5% of the population inhabits the depths of 0-15 m from the shore, 22.5 % in 15-35 m and the last 1.0% is in depths over 35m. The major factor for seasonal distribution is the sea water temperature. In summer. 62.5% of the population was found in near shore of 0-15 m depths when the temperature reaches its maximum (Zengin, 2006). By the end of the reproduction activity and the decrease in sea water temperature, generally after September, Rapa whelk moves to deeper waters and buried in substratum.

The Rapa whelk has no effective natural predator in Black Sea (as sea stars) and this is the main reason of fast population increase and invading speed. Its feeding strategy depending dominantly on mussels (Cesari and Mizzan, 1993) and its high rate of predation depleted nearly all bivalvia stocks (*M. galloprovincialis,* *Chamelina gallina, Anadara cornea*) along the coasts from Georgia border to Samsun province near the mid location of the Anatolian Black Sea coast. It is recorded that 99% of *C.gallina* population is composed of empty shells in the period of 2002/2003 (Dalgıç and Karayücel. 2006). Actually this destructive effect started by the mid of 1990s because the observations verified that *C. gallina* population was still dynamic until 1995 in the South eastern Black Sea (Zengin. 2003). In the by-catch assessment surveys in Rapana dredges the percentage of empty shells was recorded as 73% and 85% for *Anadara cornea* and *Chamelea gallina,* respectively (Knudsen and Zengin, 2006). Recently, rapa whelk starts to threaten some other mollusca and crustacean communities *(L. depurator,* Donax sp., Isopods, Amphipods and Decapods). It also threatens another egzotic Pacific originated species; Anadara cornea that invades Black Sea ecosystem in 1982.

6.9.1.2 *Growth and natural mortality*

According to the investigations conducted in the Black Sea shelf area and Kerch Strait, it is determined that maximum age of Rapana is 8 years. According to the Ukranian expert data (for 2012) (Table 6.9.1.2.1; Fig. 6.9.1.2.1);

Table 6.9.1.2.1. Length and weight data versus ages in Ukranian waters from 2003 - 2007

Age	2003		2004		2005		2006		2007		2008	
	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight
2	72,1	73,7	74,5	82,5	81,3	88,6	61,8	50,8	62,2	44,5	72,5	79,3
3	80,5	115,0	74,6	99,0	81,4	107,3	67,3	65,9	62,2	55,4	81,7	111
4	82,9	127,1	83,7	134,5	82,9	118,8	69,1	73,2	80,5	101,2	87,0	162
5	88,2	160,0	87,6	160,5	83,7	130,0	74,4	95,0	83,7	126,7		
6	92,3	182,5	97,7	208,4	95,4	187,5	77,5	104,2	95,0	185,0		
7	109,0	282,5	108,5	195,0	93,0	191,0	85,5	135,0				
8					82,0	140,0	80,0	115,0				
9			112,0	320,0								

In Turkey rapa whelk population varied from 24 to 96 mm in shell length and mean length, weight were found as 62.3 mm, 47.2 g respectively (Duzgunes et al., 1992). Saglam (2003) reported that the mean length, weight was 52.85 mm and 27.72 g respectively. This decrease in mean length could be by competing with native species for food and space or lack of sufficient food for high Rapa whelk populations. The average shell length of Rapa whelk at 0-10 m and 10-20 m depths was 62.9 mm and 60.9 mm respectively, while it was 54.8 mm at >20 m depths.74 % of Rapa whelk was found at 0-10 m depths. %24 and %2 of the population were at 10-15 m and at>20 m depths respectively. It is a typical inhabitant of coastal waters (Duzgunes et al., 1992).

In summer months the abundance of rapa whelk calculated as 0.42 indv/ m^2 in sandy regions that dredged by swept area method. Whereas the density of rapa whelk in rocky regions was high as 14 indv/ m^2 compared to that in sandy regions (Duzgunes et al., 1992). The high abundance of rapana in rocky regions in summer is due to migrate to hard substratum to spawn.

Zengin et al., (2003) found that rapa whelk is the dominant species at 0-30 m depths in benthic fauna in all seasons but especially in summer and autumn at same depths.

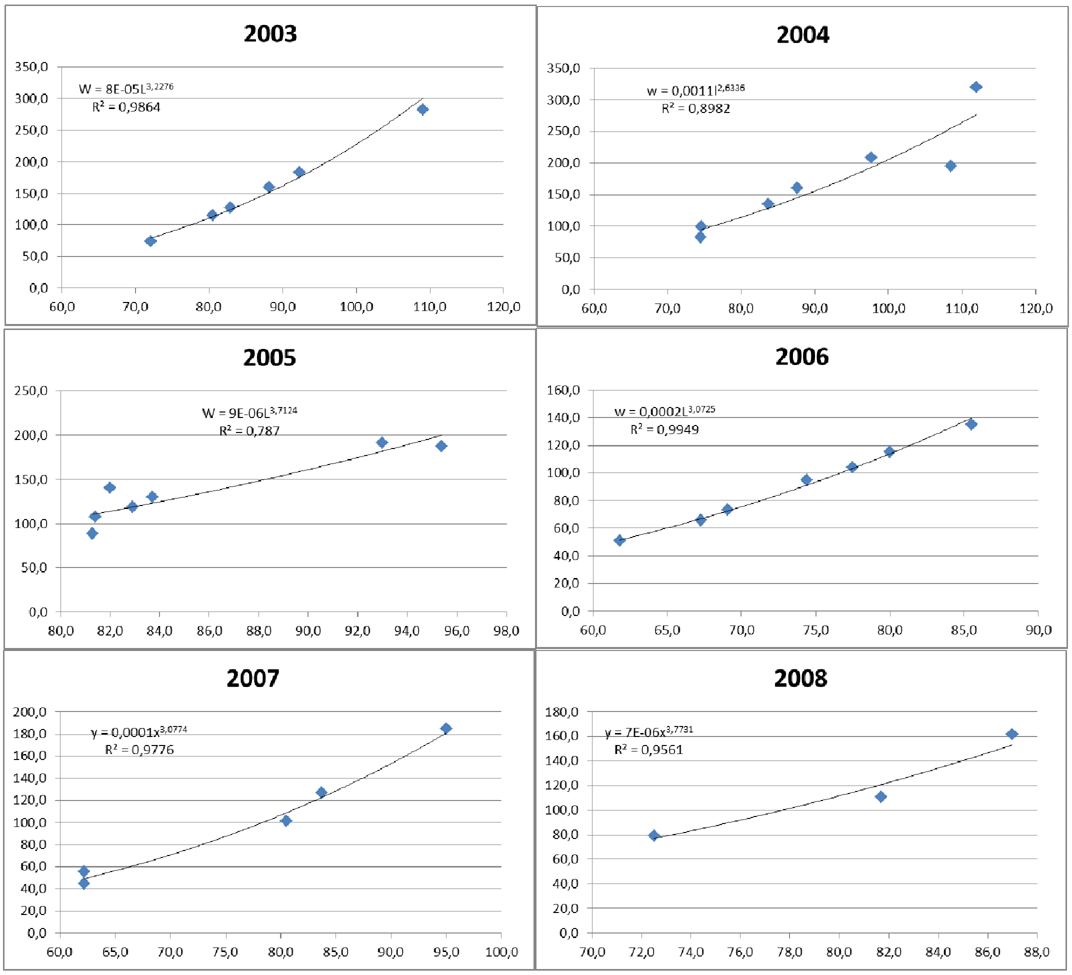


Fig. 6.9.1.2.1. Length and weight relationship of Rapana in Ukraine by years

K=0.3015 t_0=-2,6798; L_∞= 131,3 mm; M_t: M_2= 0.12. M_3= 0.54; M_4= 1.28. M_5= 1.40 (from 2010 EWG report). Length frequencies of Rapana is also given in Fig. 6.9.1.2.2. M in Turkey reported as 0.57 (Sağlam)

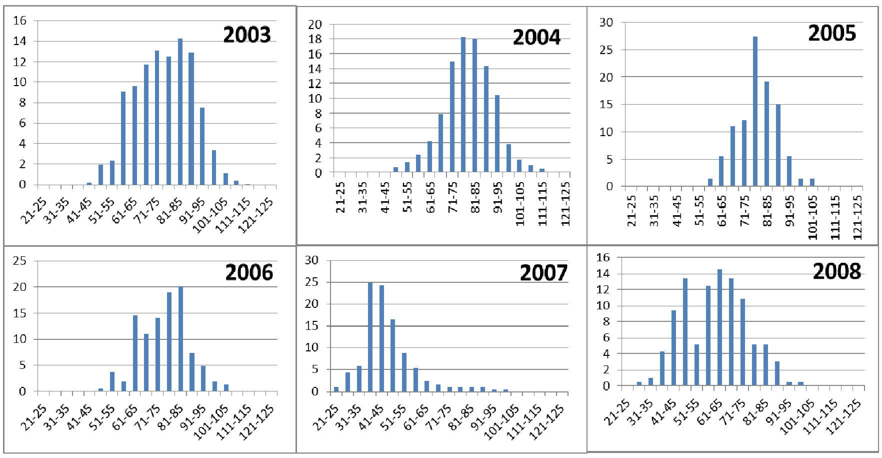


Fig. 6.9.1.2.2. Length frequencies of Ukranian catch by years

Prodanov & Konsulava (1995) reported that the commercial stock biomass and TAC of Rapa whelk are about 7482.6 and 3217.5 tons respectively in Bulgarian Black Sea coast. Also they suggested that the most suitable period of doing such assessments is July.

In case of Turkey length frequencies are given in Table 6.9.1.2.2. and Fig. 6.9.1.2.3 and Fig. 6.9.1.2.4.

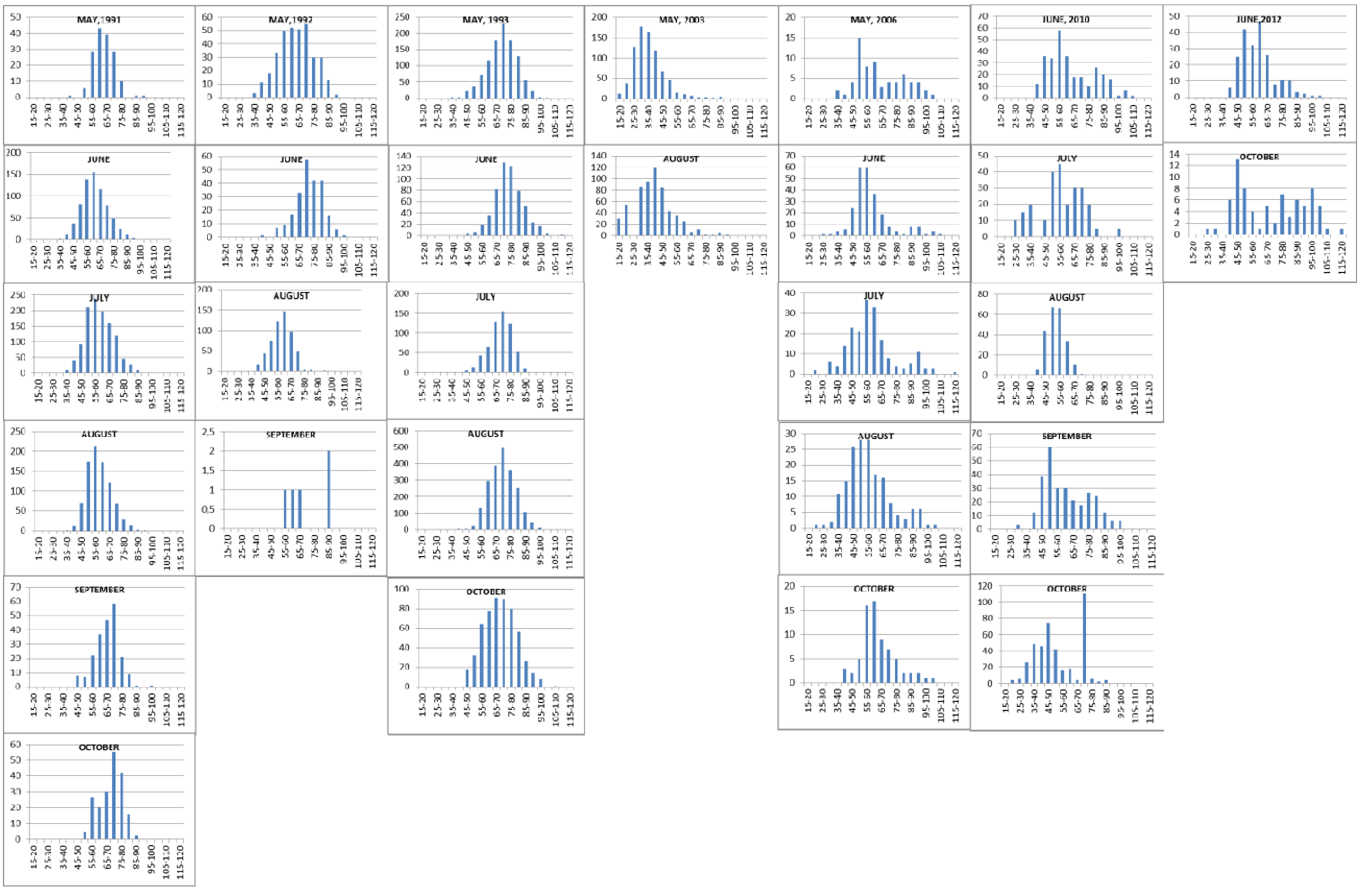


Fig. 6.9.1.2.3. Length frequency distribution of Rapa whelk stocks in the Black Sea cost of Turkey

Growth parameters of *R. venosa* along Bulgarian Black Sea coast were reported as (Prodanov et.al. 1995):

L_∞= 123.98 mm $\quad$ W_∞ = 423.75 g

k = 0.214 $\quad$ t_0 = - 0.0822

The average natural mortality coefficient was estimated as 0.5 by Prodanov et.al.,(1995) for Bulgaria and 0.57 (Sağlam) for Turkey.

According to the 2010 data (which is best fitting in recent years) W= 0003L$^{2.863}$ (R^2=0.8465). The parameters of a and b have seen rather different comparing with the Ukranian data. The reason is estimated as the Ukranian data based on average weight and lengths to ages.

Age readings only done by YugNIRO Institute in Kerch. According to the age readings maximum age was determined as 8 and population growth parameters were given as in the first paragraph (L∞=131.3 mm, K=0,3015 and t0=-2.6798 (for 2003 as the best fitting data of age length key). Other years are not deterministic due to “insufficient input data for the average length at age”.

According to the 2010 data (which is best fitting in recent years) W= 0003L$^{2.863}$ (R^2=0.8465). The parameters of a and b have seen rather different comparing with the Ukranian data. The reason is estimated as the Ukranian data based on average weight and lengths to ages.

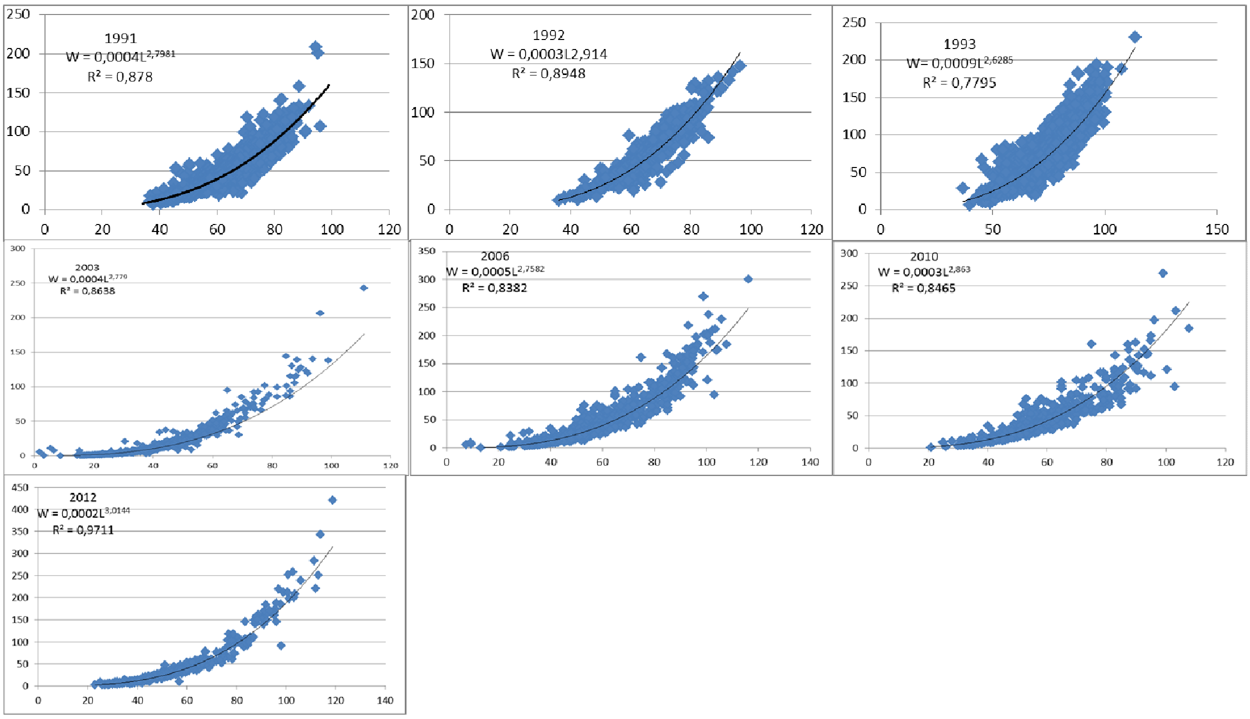


Fig. 6.9.1.2.4. Length weight relationship of Rapana in Turkish Black Sea coast

Age readings only done by YugNIRO Institute in Kerch. According to the age readings maximum age was determined as 8 and population growth parameters were given as in the first paragraph (L∞=131.3 mm, K=0,3015 and t0=-2.6798 (for 2003 as the best fitting data of age length key). Other years are not deterministic due to "insufficient input data for the average length at age".

In Turkey,data on size groups are used for the determination of the growth. In order to estimate growth parameters of the population living in Turkish coasts, age at length key of Ukrania is used to estimate averaged lengths in different size intervals. The results were given in Table 6.9.1.3 and Fig. 6.9.1.2.5.

Table 6.9.1.2.2. Length at age data for Turkey (Transformed by using age length key of UA -2003 data)

Ages	1991	1992	1993	2003	2006	2010	2012
1	41,63	42,02	41,25	39,90	44,21	42,29	45,67
2	57,84	58,80	64,50	51,90	51,90	57,98	57,65
3	70,63	72,63	73,59	68,59	68,59	71,36	70,16
4	80,47	81,95	74,40	75,87	75,87	75,32	75,20
5	85,74	104,09	82,61	83,90	83,90	87,59	92,37
			118,86	89,46	89,46	89,29	89,84
						107,50	115,02

Maximum age in the population was estimated as 7 by this method.

Growth parameters are given in Table 6.9.1.2.3.

Table 6.9.1.2.3. Growth parameters of Rapana in Turkish coastal waters

<u>For Turkey</u>

Parameters	1991*	1992	1993**	2003*	2006*	2010**	2012**
L_∞	98.29	is not fitting well	124.58	98.40	98.40	100.65	104.04
W_∞	150.40			138.22			
K	0.388		0.119	0.397	0.397	0.331	0.307
t_0	-1.972		-3.781	-1.829	-2.098	-2.194	-2.458
a***	0.0004	0.0003	0.0009	0.0004	0.0005	0.0003	0.0002

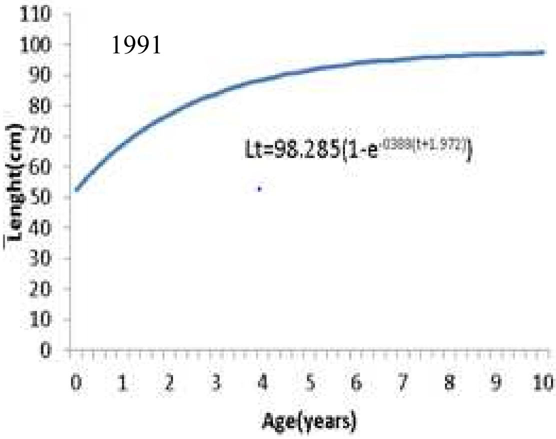
b***	2.798	2.914	2.6285	2.779	2.758	2.863	3.0144

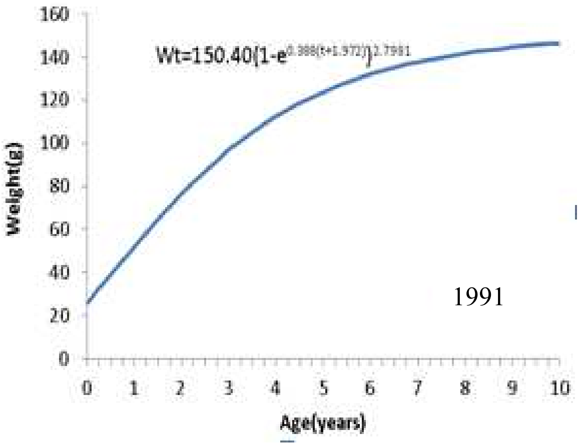
*fitting best, ** fitting if the last age group excluded *** length- weight relationship coefficients

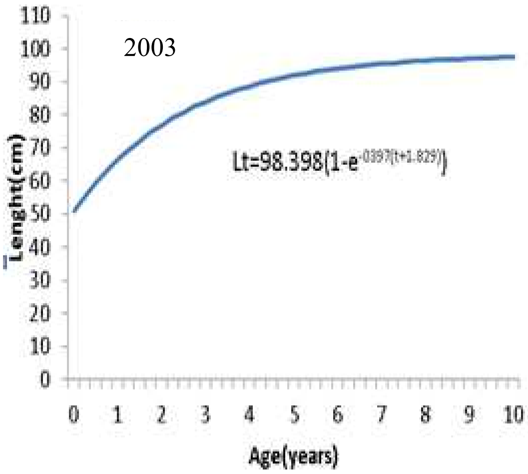
<u>For Ukraine</u>

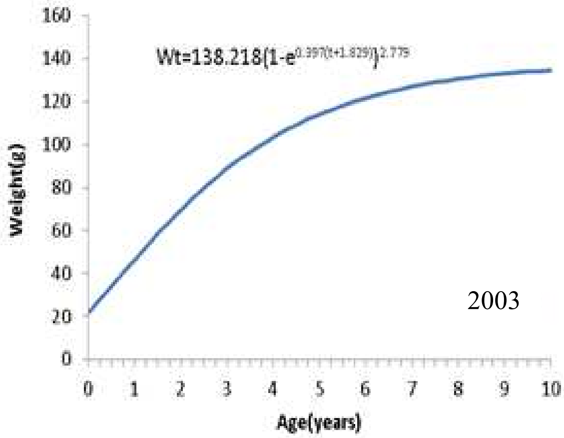
Parameters	2003	2004	2005*	2006*	2007*	2008*
L_∞	131.3	137.4				
W_∞						
K	0.3015	0.2829				
t_0	-2.6798	-2.8761				
a***	0.00008	0.011	0.000009	0.0002	0.0001	0.000007
b***	3.2276	2.6336	3.7124	3.0725	3.0774	3.7731

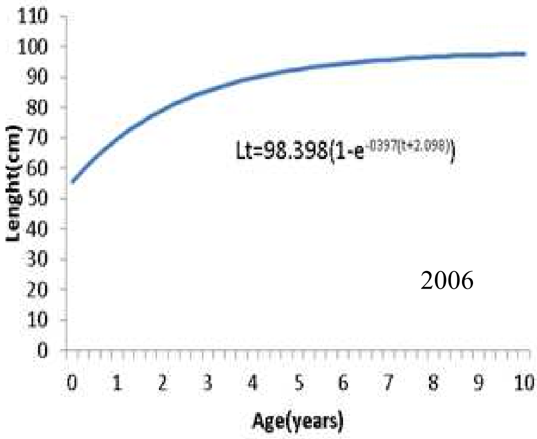
*poor data











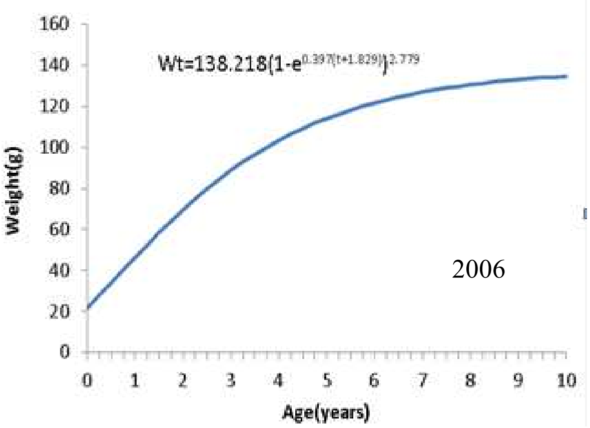


Fig. 6.9.1.2.5. Von Bertalannfy age-length and age-weight relationship of Rapana in the Turkish coasts

6.9.1.3 Maturity

The sex ratio is 1:1.6 (female: male). The first maturity length is 4.0 cm, starting from 25-30 mm with a small rate and in 30-35 mm reached %50 and after 40-45 mm size intervals all of the Rapana are mature (Table 6.9.1.3.1). Spawning occurs between June and August (Figure 6.9.1.3.1).

Table 6.9.1.3.1. Maturity index for size groups

Size groups	Maturity (%)
15-20	0
20-25	0
25-30	10
30-35	50
35-40	75
40-45	100
45-50	100
50-55	100
55-60	100
60-65	100
65-70	100
70-75	100
75-80	100
80-85	100
85-90	100
90-95	100
95-100	100
100-105	100
105-110	100
110-115	100

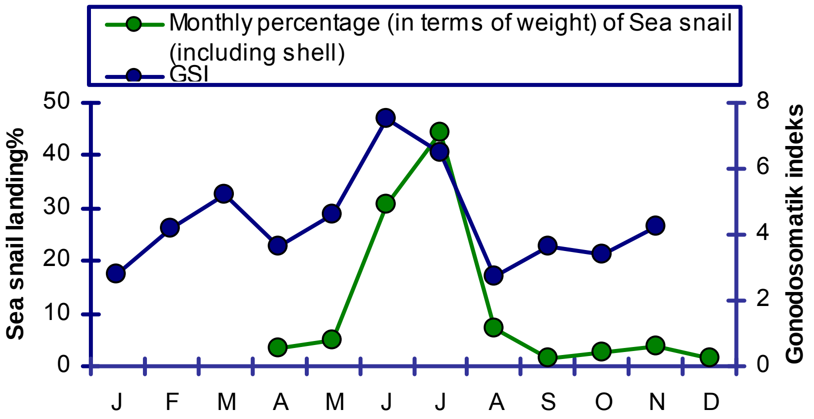


Figure 6.9.1.3.1. The relationship between the monthly landings and the reproduction period GSI of Rapa whelk.

6.9.2 *Fisheries*

6.9.2.1 General description

Rapa whelk has become a commercially valuable resource with high demand on theinternational market. The commercial value of thisresource increased initially in Turkey during 1980s and then in Bulgaria (1990s). In Romania, medium-largescale 'subsistence' harvesting is likely to develop into an export-oriented industrial-scaleenterprise in future years. In Ukraine,*R. venosa* catch are limited to local subsistence fisheryand souvenir manufacture/trade (Black Sea TDA. 2008. BSC SOE. 2008).

Positive economic effects from *R. venosa* fishery are counteracted by negative ecologicalside-effects of destructive fishing practices used in Turkey and Bulgaria where *R. venosa* isharvested with dredges and beam trawls, in the latter country illegaly (Black Sea TDA. 2008). In Bulgaria, Rapana fisheries started in 1994 by method of scuba diving. but later illegal use of beam trawls have been also observed. For that reason, the official landings are misreported to some extent. Due to fact that the Rapa whelk products are export orientated. the real value of catches could be estimated by official export data. In 2012, use of beam trawls permitted by the government.

In contrast, in Romania *R.venosa* isselectively fished by SCUBA divers, a sustainable method which does not disturbthe habitat or involve by-catches of other animals. However, signs of over-harvesting arealready evident in some areas (Black Sea TDA. 2008).

Turkey has been conducting large-scale harvesting of sea snail since the mid -1980s. The Turkish catch remained, however, much higher than other countries, followed by Bulgaria (*BSC SOE, 2008, GFCM Capture Production 1970-2006, National Fisheries Statistics 2007-2009*) (Table 6.9.2.1.1, Fig. 6.9.2.1.1)).

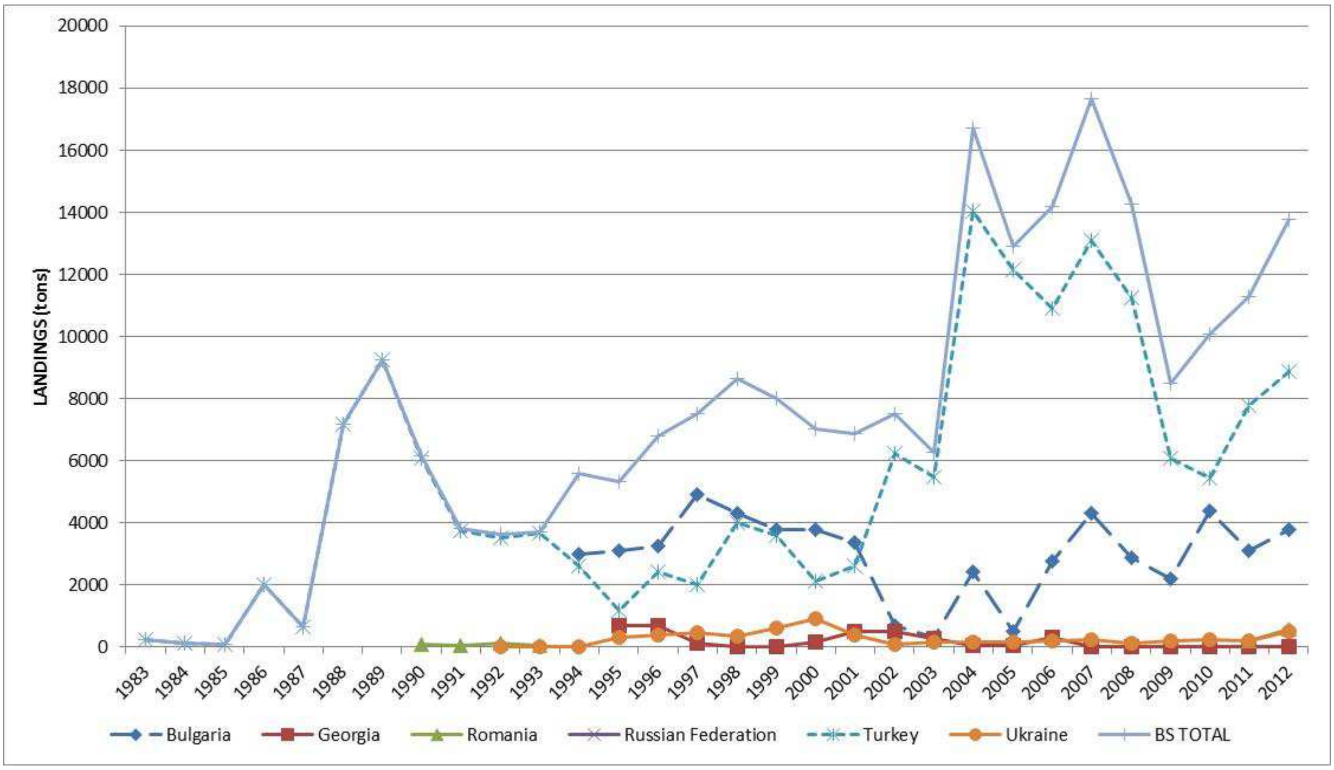


Fig. 6.9.2.1.1. Rapa whelk landings in the Black Sea by countries

CFRI of Turkey was participated in a study (Knudsen et al.. 2010) evaluating the rapa whelk fishery by its socio-economic and administrative structure and also its population structure and predation on benthic habitats and bivalves communities. Following the years of 2006-2008 a study was carried out to develop new technologies to mitigate the effects of traditional dredges and beam trawls on benthic ecosystem. In this study. the efficiency of new trap models was tested and it is tried to determine whether they can be an alternative to traditional fishing methods (Sağlam *et al*., 2008). But the different trap models were found insufficient by the fishermen. These trap models were unfortunately not used in practice. even though they were supported financially by Fishery Cooperatives and the rapa whelk processors in Samsun (Yesilirmak-Kizilırmak) where the rapa whelk intensely exploited along Turkish coasts. The fishermen did not use these new catch device and they continue with their traditional methods.

According to the technical report (Iotov, 2011) prepared for European Commission, regarding the status of Black Sea fishery for the date and the future management that was presented to European Parliament revised the case of rapa whelk in Black Sea as other species. The report focuses on the importance of research to define the safest fishing techniques for demersal stocks, particularly the veined rapa whelk (*Rapana venosa*). This is of particular importance for the ecosystem of the Black Sea, as it has been revealed that rapa whelk is in the position of 'a predator without enemy thus exercising great pressure on natural filters of sea waters like blue mussel (*Mytilus galloprovincialis*) and striped venus clam (*Chamelea gallina*) and seriously endangering the ecological balance of the Black Sea.

Regarding this importance, though several researches from different localities were done on several aspects such as biology, population and ecology of rapa, still little is known and the present data is lack of any standards as sampling, ageing etc. We have no retrospective data including time-series and the data provided already is not sufficient in quantity and quality for a stock assessment model. Furthermore, there is no current study on rapa considering the parameters required for stock assessment in all the Black Sea countries. If a stock assessment program is planned to be run. The first attempt has to be the development of a standardized method for data collection and compile.

The future work flow for rapa whelk was discussed by Black Sea WG and it was concluded to monitor rapa with case studies at least for now and to encourage countries to plan surveys in order to collect new data with a standard methodology required in stock assessment procedure.

6.9.2.2 Management regulations applicable in 2012 and 2013

In Bulgaria, fisheries on *Rapana* are permitted only by scuba diving method and license system in also in force. In Ukraine, annual limit for sea snail harvesting up to 400 t has been introduced since 2002. In Turkey, MFAL implemented some limitations to the fishery of Rapa whelk by yearly circulars those can be mentioned in three items. The first was the fishing method that permits scuba diving in western part while dredges (mesh size as minimum 40 mm) are allowed in eastern part. The second was about fishing period. Scuba diving was allowed throughout all year but dredges are banned between 1 May and 30 August. In addition, fishing at nights was also banned. The third one is about the area limitations such as closure of 500 m far from the coast. Actually, these limitations never came into use and illegal fisheries increased in following years. The possible reasons for illegal fisheries may be considered as:

1. The Rapa whelk migrates to the coastal zone to reproduce in summer months (5-15 m depths) and the illegal fishery increases especially in this period due to abundance and the gear efficiency resulted in higher catches. The Rapa whelk population moves to deep water in autumn when the temperature lows and so the decrease of the catch in this legal period compels the fisherman to illegal activities (Fig. 6.9.2.2.1).

2. The meat yield reaches its highest percentage in summer and landing costs higher. In the legal period (autumn) the condition of Rapa whelk declines. So the meat yields and processing plants involuntary to pay well prices (Fig. 6.9.2.2.2).

3. In this legal period the artisanal fishermen harvesting Rapa whelk leaves the dredges and focuse for bonito fishing which is more profitable.

4. Except the banned period some of small scaled fisherman works as a crew in large vessels (trawls and purse seines) and already have a job. By the closure of the fishing season for the large vessels, they want to drive profit from Rapa whelk and fish in the illegal season.

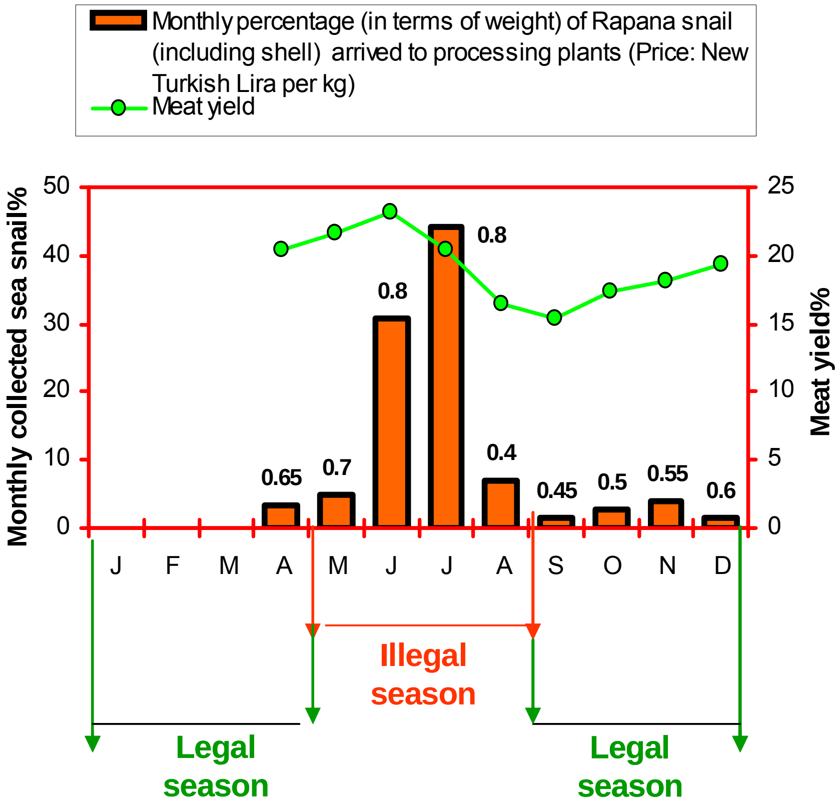


Figure 6.9..2.2.2. The relations between fishing season, landing, meat yield and price for Turkey (Zengin. 2005).

6.9.2.3 Catches

6.9.2.3.1*Landings*

Turkey has been conducting large-scale harvesting of sea snail since the mid -1980s. The Turkish catch remained, however, much higher than other countries followed by Bulgaria (*BSC SOE. 2008. GFCM Capture Production 1970-2006. National Fisheries Statistics 2007-2009*). Table 6.9.1.4.1 lists the national landings.

In Turkey, harvesting of sea snail has been firstly permitted by MARA in 1980's. The fishery sector expanded including fishermen, commission agents, industrial foundations such as processing plants etc., especially in the Eastern Black Sea. At the beginning, 225 artisanal fishermen were operating with dredges (algarna) along the Eastern Black Sea, but the number of fishermen reached 421 by an increase of 87% in the next ten years (Zengin and Knudsen, 2006). Analysis of fisheriesalong the eastern coast of Turkey (Samsun Province) showed that number of vessels using dredgesfor sea snail harvesting in 2000-2005 increased by large rates, especially in the vessel group 33-149HP. These are typical boats that combine sea snail dredging. bottom trawling and gill net fishing(Zengin. 2006). Although the resource of this mollusk is still withstanding such highintensity of fisheries, a large-scale implementation of dredges has a destructive effect on the bottombiocenoses and the ecosystems as a whole.

The Turkish fishermen working on *Rapana venosa* mostly have vessels with 6-17 m in length. A single dredge is used in vessels smaller than 8 m and the larger ones generally used as pair dredging. Actually, the use of pair dredges is prohibited by government regulations. But fishermen generally use them to obtain more product and they continue fishing also at night time, illegally. The number of vessels in Samsun district was 421 by 2005 and nearly half of them (232) had no licences for rapa whelk fishing. These vessels intensively operates in inshore benthic between depths of 5 and 33 m but mostly around 13 m. Table 6.9.1.4.2 shows the number of vessels having license for Rapana catch in Turkey.

The landings of rapa whelk in Eastern Black Sea was 10 000 t in 1989, changed around 3 000 tons in average (1 - 6 thousand tonnes) between 1990 and 2000 according to TUIK official data. In the following decade landing of rapa whelk increased and reached its maximum as 14 000 t in 2004. This trend continued more or less stable (11 000-14 000 tons) until 2009. A sudden decrease was recorded in landing as 6 000 tons in 2009. The increase in 2000 - 2010 may be explained by the depletion of major demersal stocks in the area and effect of fishermen on rapa whelk fishery for better economic advantages. In 2012, production in all countries increased slightly to the levels as 3793 tons for Bulgaria, 589 tons for Romania, 8893 tons for Turkey and 513 tons for Ukraine (Fig. 6.9.1.4.1, Table 6.9.1.4.1).

Until the early1990s, along the Ukrainian coast the sea snail was harvested in artisanal way forfine shells used as souvenirs (BSC SOE. 2008). At the same time, the meat of harvested mollusks was thrown away and rarely it was used as feed for animals and more rarely as an exotic food for humans. Along the coasts of Ukraine the densest concentrations of Rapa whelk are found in depth 3-15 meters along the coast of the Crimea from Mezhvodnoye (the Karkinitsky Bay) to the Cape Takil and in the Kerch Strait. It is in this area of the Black Sea where a specialized harvesting (by Khizhyak's dredge and hand harvesting of divers) for Rapa Whelk has been conducted since 1995 (Shlyakhov V. A.. Mikhaylyuk A. N.. 2010). In the Black Sea the maximum harvesting of Rapa Whelk was observed in 2000 at the level of 913 tons. among which 325 tons were harvested on the ground Cape Takil – Feodosia by 19 gangs of harvesters, equipped with aqualungs and using 7 dredges. In the Kerch Strait the maximum harvest of Rapa Whelk made up 49 tons in 2007.

After 1983, Rapana stocks haad been started to exploit in Turkey according to the demands of Asian markets, mainly Japan, to processed as frozen meat. Production has raised its maximum about 9500 tons till the period that the main collapse in fisheries in 1988-89. After a period of restoration, landings of Rapana increased to 14000 tons levels in 2005. At present, the catch of Rapana is around 6500tons,

Table 6.9.1.4.1. Rapa whelk landings (t) by countries (FAO Fisheries Statistics. GFCM Capture Production 1970 – 2006 and National Fisheries Statistics 2007 - 2009).

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	BS TOTAL
983					235		235
1984					122		122
1985					78		78
1986					2030		2030
1987					643		643
1988					7195		7195
1989					9239		9239
1990			75		6094		6169
1991			70		3738		3808
1992			110		3519	14	3643
1993			45		3668	3	3716
1994	3000				2607	5	5612
1995	3120	700			1198	303	5321
1996	3260	711			2447	378	6796
1997	4900	118			2021	476	7515
1998	4300	-			3998	371	8669
1999	3800	-			3588	619	8007
2000	3800	184			2140	913	7037
2001	3353	517			2614	400	6884
2002	698	503			6241	93	7535
2003	325	295			5500	154	6274
2004	2428	65			14034	182	16709
2005	511	70			12156	171	12908
2006	2773	300			10910	200	14183
2007	4310	-			13106	250	17666

2008	2872	-		11268	138	14278
2009	2214	-		6085	191	8490
2010	4381	-		5460	230	10071
2011	3119	-	218	7770	189	11296
2012	3793	-	589	8893	513	13788

Table 6.9.1.4.2. Number of licensed vessels for Rapana in Turkey in the Black Sea

Years	Number of vessels
2000	121
2001	116
2002	153
2003	179
2004	495
2005	596
2006	555
2007	504
2008	
2009	
2010	
2011	
2012	240

Prior to the commercial fishing started in Bulgaria, the biomass on the coastal grounds between Kaliakra and Pomorie was assessed at about 2 thousand tons (Prodanov and Konsulova, 1993). Taking into account all the area and the buried part of mollusks, its total biomass was assessed as 7.5 thousand tons. The average shell length of sea snail in 1984 was 71.1 mm (Prodanov and Konsulova, 1995). Although bottom trawling and dredging were officially forbidden, these fishing gears were used actively in sea snail fishery. According to the assessments of the Private Bourgas Fishery Association, sea snail landings almost 7 times higher than the official report 8557 tons in 2005 (TDA Technical Task Team National Experts. Bulgaria report. Raykov, 2006).

Illegal bottom trawling for harvesting of *Rapana venosa* along the Bulgarian Black Sea shelf hasraised ecological concerns with respect to the benthic communities and especially the mussel beds.The population decline of the habitat-structuring species *Mytilus galloprovincialis* in theimpacted areas was accompanied by degradation of the associated benthic community from "musselbed" type to "silt bottom" type dominated by opportunistic polychaetes and oligochaetes (Zenetos *et al*., 2007).

National Agency of Fisheries and Aquaculture of Bulgaria started to collect data for export of Rapa whelk and CPUE data, which could be used for estimation of real value of landings – Table 6.9.1.4.3.

Table 6.9.1.4.3. Export data of Bulgaria for *R. venosa* in 2009.

Origin BULGARIA	Net weight (kg)
Frozen Rapa whelk	146164
frozen sweetbread from Rapa whelk	326178
frozen meat from Rapa whelk	572102
frozen meat from Rapa whelk with shells	59204
Total	**1103648**

In the Romanian Black Sea sector, *R. venosa* was first found in 1961 at the mouths of the Danube (Grossu. 1964), from where it rapidly spread towards the South becoming a common species (Gomoiu. 1972). Today it is encountered on all types of substratum (rocky. sandy. muddy) at depths between 3 and 45 m. the maximum densities being registered on the natural and artificial substrata.

Investigations on *R. venosa* were conducted in the Romanian Black sea area during the period 2006-2008 and the following results were obtained:

1. The average length of the about 7.000 Rapana individuals selected ranged between 35 and 120 mm. the modal length being 90 mm. while the average one - 87.08 ± 0.36 mm. The average numeric density is 0.88 ± 0.02 ind/m^2 (which corresponds to a total population of 100.16 ± 2.25 million individuals on the rocky substratum (113.53 km^2) on the Romanian sector of the Black Sea littoral.

2. The total number of capsules laid by the female during one reproductive season (laboratory rearing) varied between 184 and 450, while the number of eggs in one capsule was 976. Thus, the fecundity was estimated between 179.000 and 400.000 eggs/ind-1/an-1.

3. The size of the eggs is 230-250 µm, while that of the newborn larva shell is 0.41 x 0.3 mm. The intercapsular development duration until hatching was of 14-17 days, at a 20°C temperature. The veliger larvae are planktotrophes and can survive in the plankton for a long time (80 days) ensuring the long distance spreading if they find sufficient food in the plankton. If the plankton contains sufficient food, the larvae can metamorphose and start their benthic life in only 5-7 days.

4. The population diversity on the Romanian Black Sea Sector is higher than those of the populations in the Northern Adriatic Sea. Despite the smaller distances between the collecting stations. This high diversity is probably due to the fact that pontic populations are 10-30 years older than those in the Mediterranean basin.

5. *R. venosa* stocks in the Romanian Black Sea sector were estimated for the first time. The underwater transects method for stock evaluation was used as a premiere in the Black Sea basin. The commercial *R. venosa* stock was estimated around 13.19 ± 0.42 thousand tons, while the TAC level recommended for the fishery management is la 5.7 ± 0.2 thousand tons. We consider that, presently, the stock can sustain a much greater fishing effort. Thus we recommend the temporary suspension of the prohibition period for this species.

6. The age of *R. venosa* was determined for the first time through sclerochronology.

7. The first microsatellite library for the *R. venosa* species was created and six microsatellite loci were characterized as a premiere for this species.

8. The age at the first breeding was determined. 2-4 years corresponding to a shell length of 70-80 mm. In order to ensure at least one reproduction during the life span of an individual. In order to restore stocks for better exploitation levels, we recommend the modification of the minimum size allowed by the catch from 50 mm. presently to 80 mm.

9. The imposex in Rapa population was also observed due to TBT pollution in the Black Sea.

The official catches reported at the Romanian littoral (kg) are: in 2008 - 85 kg and in 2009 – 1761 kg. The catches are obtained by hand of divers.

6.9.2.3.2*Discards*

No information was made available to the EWG 13-12.

6.9.2.4 Fishing effort

Number of vessels harvesting Rapana is given in the Table 6.9.1.4.2, as 240 in 2012 in Turkey. There is no data about to total GT, total operational hours, etc.

6.9.2.5 Commercial CPUE

There are some estimates of CPUE based on some assuptions from rapa whelk fishery in Turkey(Table 6.9.1.4.4) estimated for only several years using 2 different methods. In the first method, number of vessels provided from MFAL FIS databeses from 2000 to 2007 and CPUE is calculated from the landings for relevant years. From prior to 1991, number of vessels assumed same as in 2000 (Table. 6.9.2.5.1 and Fig.6.9.2.5.1)

Table 6.9.2.5.1. CPUE of Rapana estimated by 2 different methods

Years	# Vessels	Production (Turkey)	CPUE(ton/vessel)	CPUE (ton/km2)
1991	121	3738	30,89	4,6
1992	121	3519	29,08	6,0
1993	121	3668	30,31	5,4
1994	121	2607	21,55	
1995	121	1198	9,90	
1996	121	2447	20,22	
1997	121	2021	16,70	
1998	121	3998	33,04	
1999	121	3588	29,65	9,1
2000	121	2140	17,69	
2001	116	2614	22,53	5,4
2002	153	6241	40,79	
2003	179	5500	30,73	0,6
2004	495	14034	28,35	
2005	596	12156	20,40	
2006	555	10910	19,66	1,8
2007	504	13106	26,00	
2008		11268		
2009		6085		
2010		5460		
2011		7770		
2012	240	8893	37,05	10,1

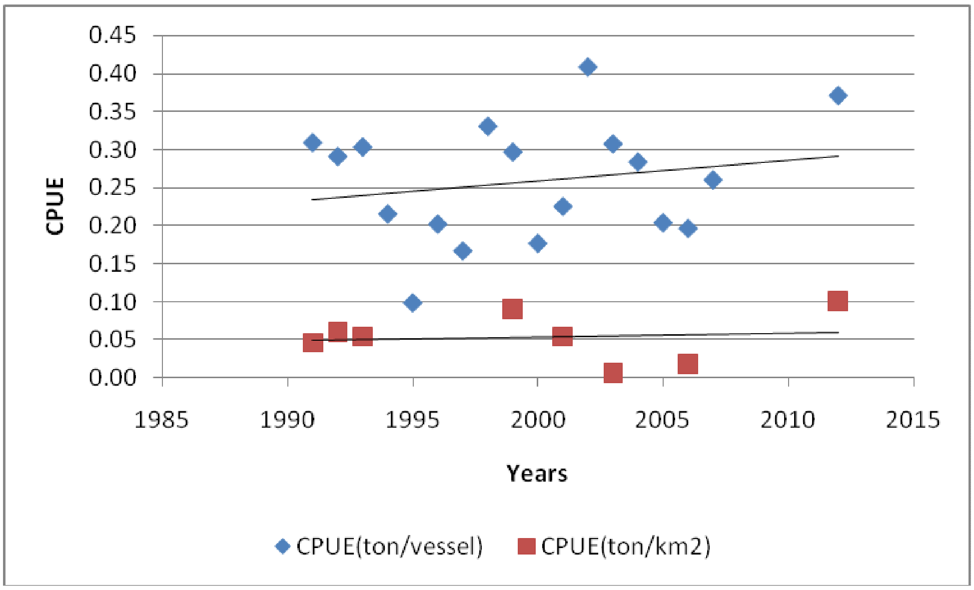


Figure 6.9.2.5.1CPUE rates for Rapana in Turkish Black Sea coasts.

According to the Bulgarian data, CPUE as kg per h is given in Table 6.9.2.5.2.

Table 6.9.2.5.2. Catch per unit effort (kg/h) of Bulgaria on Rapa whelk fishery by fleet segments in 2008 and 2009.

Fleet Segment / Average CPU	LOA>0<6		LOA=>6<12		LOA=>12<18		LOA=>18<24		LOA=>24<40	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Rapana RPN	305.69	238.38	461.88	529.95	722.83	611.99	744.84	768.24	no	no

According to the other survey performed in the past by CFRI, when the maximum catch is obtained in summer period by commercial dredges along Samsun in 2005 (Figure 6.9.2.5.2.), catch per unit of dredges in June and July is estimated as 70 and 100.9 kg/hour/vessel. The CPUE decreases in spring and autumn. It reaches to its minimum in spring; 5.7 and 26.3 kg/hour/vessel for April and May. respectively. It is considered to be related to temperature fall and the movement of *Rapana* to deeper waters. The CPUE increased slightly in autumn and estimated as 57.2 and 40.3 kg/hour/vessel for September and October.

The CPUE of beam trawls (algarnas) operating for rapa fishery from 2005 to 2010 were roughly estimated as 73.1 kg/h. 77.7 kg/h. 70.9 kg/h. 67.4 kg/h. 54.0 kg/h. 67.9 kg/h. respectively. The CPUE values seemed compatible with landings.

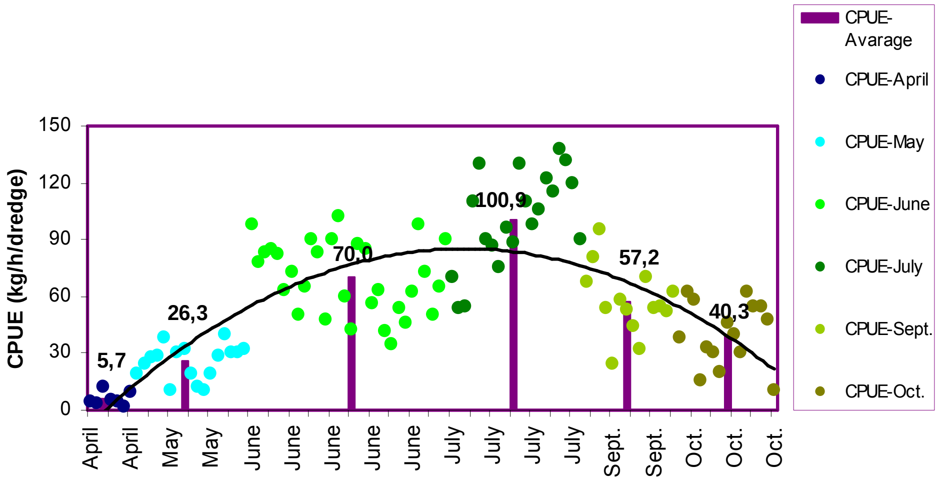


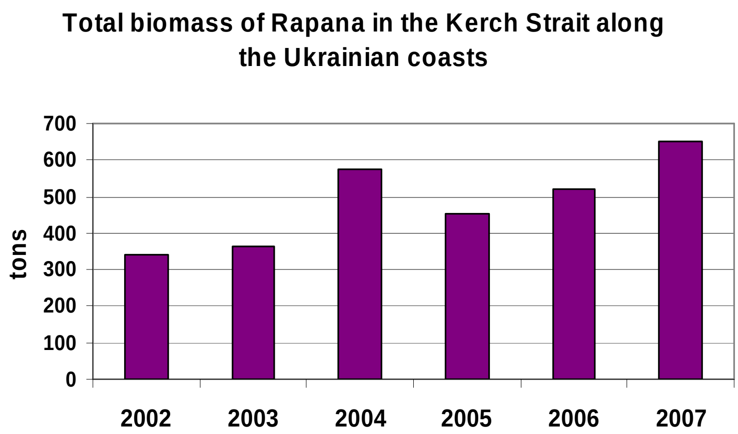
Figure. 6.9.2.5.2. CPUE data obtained from rapa whelk commercial dredges in Samsun coasts for 2005.

The significant increase in Rapa whelk abundance has been observed since 1990. which leads to some ecological problems in near shore benthic communities. The feeding of Rapa whelk on bivalve species as a major source of food creates a high predation pressure that impacts both itself and other demersal species feeding on the same source. The scarcity of food lowers the growth rate of *Rapana* and prevents to reach harvestable length.

6.9.3 *Historical information on stock status*

6.9.3.1 Description

The earliest data about rapa whelk from Ukraine is length- frequency distributions for 1972 and 1973. These length compositions are up to 2008 with some intervals (Table 6.9.3.1.1). Research on biological parameters, distribution and stock assessment (by dredges and visual divers' surveys) of Rapa Whelk in the Ukrainian territorial waters were undertaken in 1990, 1994 and 1998 in the area from Takil Cape to Chauda Cape. Stocks were respectively assessed as 2.8 thousand tons. 1.5 thousand tons and 1.3 thousand tons. The former two assessments belonged to the initial commercial exploitation of this ground. The latter is for the period of the intensive fisheries. Reduction in Rapa Whelk stocks from 1.5–2.8 thousand tons (virgin population in 1990-1994) down to 1.3 thousand tons (exploited population in 1998) is the evidence of dredging impact. At the same time it is known that instead of the permitted by the Fisheries Regulations Khizhnyak's dredge which is a sparing (protective) fishing gear of this class, knife-edge drags were widely used affecting greatly the bottom biocenoses. In 1994 sea snail stocks were assessed along the southern and western coasts of the Crimea from Cape Ilya to the Cape Evpatoriisky. Rapana stock was estimated in this area as 14 thousand tons and the limit for its harvesting in the waters of Ukraine begin to be established as 3 thousand tons. After 2000 small-sized sea snail of 50-60 mm long was predominant in the catches from this ground. The causes of the observed rejuvenation of Rapa whelk population at present are difficult to establish without scientific research activities. The most probable cause is overfishing accompanied by the intensive harvesting of individuals of older ages (more than 75 mm long) and great amount of the non-reported harvest. Therefore, since 2002 annual limit for sea snail harvesting in the Ukrainian waters was reduced down to 400 tons. After limit reduction fisheries intensity and Rapa Whelk harvests reduced greatly and by mid 2000s there has been appeared information about increase in abundance and individual size of this mollusk near the coast of the Crimea. In Ukrainian waters of the Kerch Strait in recent years surveys of Rapa Whelk are made regularly. Their results are shown in Fig. 6.9.3.1.1.



Fugure 6.9.3.1.1. The dynamic of Rapa Whelk biomassin the Kerch Strait. Ukraine.

There are biological studies about Rapa whelk in Ukraine including weight-at-length and weight-at-age information for 2003-2008. The age groups ranged between 2-9 years. The minimum length was 61.8 mm and the maximum was 112.0 mm. The minimum and maximum weight values are 44.5 g and 320.0 g in these five years' time. The mean lengths for this period (2003-2008) were 65.63 mm. 79.83 mm, 74.96 mm, 73.66 mm, 76.72 mm and 80.4 mm and the mean weights were 117.6g, 149.9 g. 120.4 g, 91.3g, 102.56 g and 117.43 g. The age composition of Rapa for 2003-2008 is represented in 6.9.1.4.5. Ukraine has an age-length key for 2003-2008 that can be used to transform any length-frequency distribution to age (Shlyakhov and Mikhaylyuk, 2010).

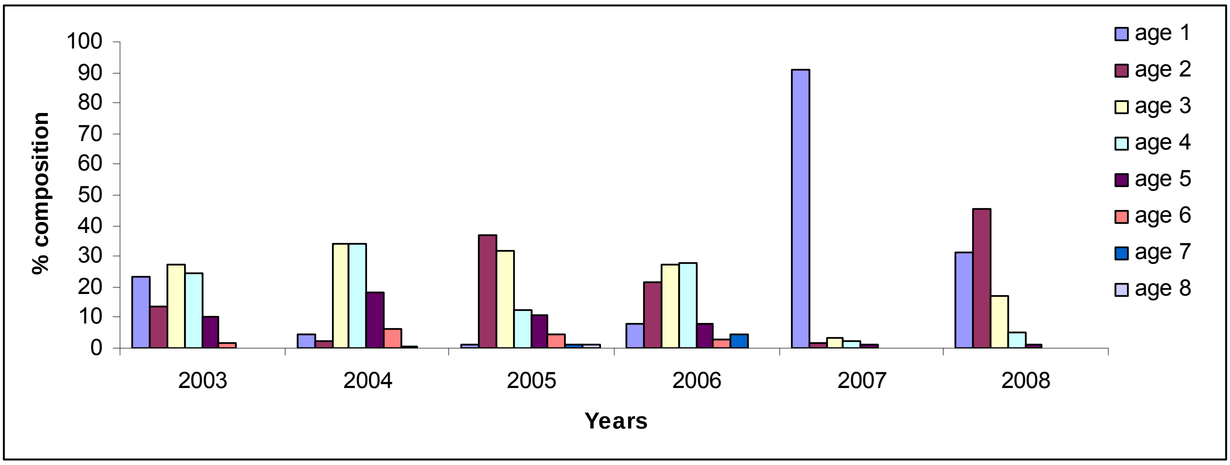


Figure 6.9.3.1.2. The age composition of rapa in Ukraine for 2003-2008.

6.9.3.2 Input parameters

The following table 6.9.3.2.1 lists historic size composition of Ukraine landings.

Table 6.9.3.2.1. Length composition of rapa whelk in Ukrainian waters of the Black Sea and Kerch Strait. %.

L, mm	Years																	
	1972	1973	87	89	90	92	94	97	98	99	2000	2001	2002	2003	2004	2005	2006	2007	2008
11-15																			
16-20																			
21-25																		1,0	
26-30		0,1																4,4	0,5
31-35			0,1															5,8	1,0
36-40			0,1						0,4						0,03			24,9	4,2
41-45	0,3	0,3	0,2						1,5	0,4	0,8	0,4		0,2	0,1			24,4	9,4
46-50	0,6	0,7	0,2						6,8	1,4	0,8	3,2		1,9	0,7		0,6	16,6	13,5
51-55	1,3	1,6	0,1					1,8	13,3	5,7	2,4	13,6	0,8	2,3	1,4		3,7	8,8	5,2
56-60	3,3	4,1	0,3	0,1				7,9	11,0	14,1	7,2	17,5	1,6	9,1	2,5	1,4	1,8	5,4	12,5
61-65	3,5	4,0	0,9	0,1		0,5	2,3	11,3	9,9	16,2	7,2	13,5	11,2	9,6	4,2	5,5	14,6	2,4	14,6
66-70	3,3	4,6	2,3	0,4	0,3	0,8	1,5	12,4	10,6	9,1	1,6	9,3	15,7	11,7	7,8	11,0	11,0	1,5	13,5
71-75	5,7	4,9	4,5	2,3	6,2	5,2	8,5	18,9	11,8	11,3	16,9	8,5	16,1	13,2	14,9	12,2	14,0	1,0	10,9
76-80	10,9	6,3	4,1	3,5	12,4	6,6	7,7	16,0	13,3	10,1	15,3	6,6	23,2	12,5	18,2	27,4	19,0	1,0	5,2
81-85	17,5	7,4	7,9	8,1	17,6	16,8	23,1	13,4	6,1	9,3	13,7	6,5	15,6	14,3	18,0	19,2	20,1	1,0	5,2
86-90	15,0	7,2	9,7	8,1	16,9	15,2	13,8	4,5	8,0	8,1	16,1	8,1	7,1	12,9	14,4	15,0	7,3	1,0	3,1
91-95	16,9	9,6	11,9	12,2	16,9	18,8	20,0	3,2	2,7	7,9	8,1	6,4	6,5	7,5	10,5	5,5	4,9	0,5	0,5
96-100	8,1	8,5	12,9	14,4	16,0	12,7	15,4	1,6	1,5	3,6	4,0	3,3	1	3,4	3,8	1,4	1,8	0,5	
101-105	4,4	10,9	12,6	15,7	4,9	12,1	6,1	3,7	1,1	1,0	3,2	1,9	0,4	1,1	1,8	1,4	1,2		
106-110	3,2	10,2	11,4	14,2	5,2	6,1	1,5	2,6	0,4	1,2		0,8	0,8	0,4	1,0				
111-115	2,8	6,8	6,6	9,3	1,9	3,6		2,4	1,1	0,2	1,6	0,3		0,005	0,5				
116-120	1,9	6,2	6,1	5,7	1,0	1,4		0,3	0,4	0,2					0,1				
121-125	0,5	4,0	4,2	3,8	0,6					0,2					0,03				
126-130	0,8	1,3	2,5	1,7							0,8								
130-135		0,6	1,2	0,3															
135-140		0,1	0,2	0,1															
N			1496	2624	307	362	130	380	263	495	124	941	508	1790	2992	72?	160	205	192

Distribution of rapa whelk catches by size and age groups during the survey in 1992 (Prodanov et.al. 1995). is given on Figure 6.9.3.2.1.

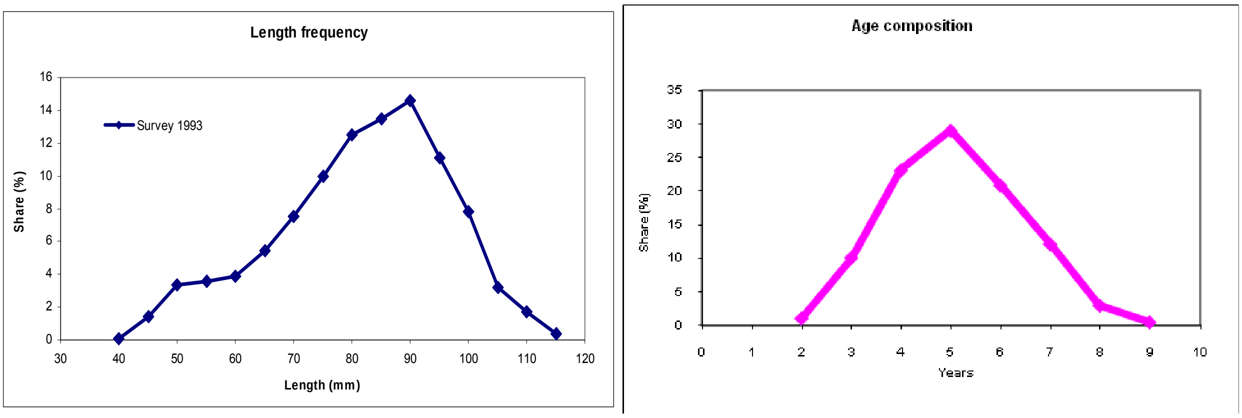


Figure 6.9.3.2.1. Size and age structure of R. venosa in 1992 along the Bulgarian Black Sea coast (after Prodanov et.al. 1995)

The overexploitation of eastern stocks speeds the decline through the ends of 1990s and a significant difference in mean length appears between western (Samsun and Bulgaria) and eastern (Georgia and Ordu) stocks. For example the mean length is 4.7 cm (1.1-10.7 cm), 6.4 cm (2.5-11.7 cm) and 6.9 cm (3.5-11.9 cm) for eastern stocks. Samsun (Kizilirmak and Yeşilirmak shelf area) and western stocks. respectively (Knudsen and Zengin. 2006). Therefore, eastern *Rapana* fishermen move to Samsun area and further west. It is also confirmed by a number of studies that the mean length decreased contrarily to the increase in biomass. The mean length was recorded as 11.0 cm in 1986 (Ünsal. 1989). 6.7 cm in 1991 and 6.5 in 1992 (Düzgüneş et al. 1992) 5.4 cm in 1999 (Emiral. 2003) and 4.5 cm in 2003 (Zengin. 2006) (Figure 6.7.4.1.2.4).

The possible reasons of the decrease in mean length may be considered due to: (1) The overexploitation of larger length groups due to high demand for market and export. (2) The reduction of natural food sources as a result of intensive Rapa predation and consequential poor feeding period.

Some bio-ecological parameters are estimated during the study carried out on eastern Rapa whelk population along Trabzon coasts (Emiral, 2003). The measured lengths have ranged between 2.0 and 9.5 cm. with mean length of 5.3 cm. The shell width is calculated as 3.7 cm and the mean weight as 27.7 g.

In case of Turkey, majority of the production has been provided from the Black Sea (Fig. 6.9.3.2.2, 6.9.3.2.3 and 6.9.3.2.4).

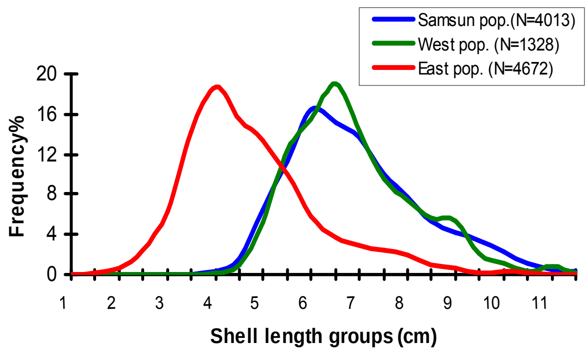


Figure 6.9.3.2.2. The length frequency distributions of Rapa whelk caught by commercial dredges in fishing season 2005 along eastern coasts (Georgian border-Ordu), Samsun and western coasts (Samsun-Bulgaria).

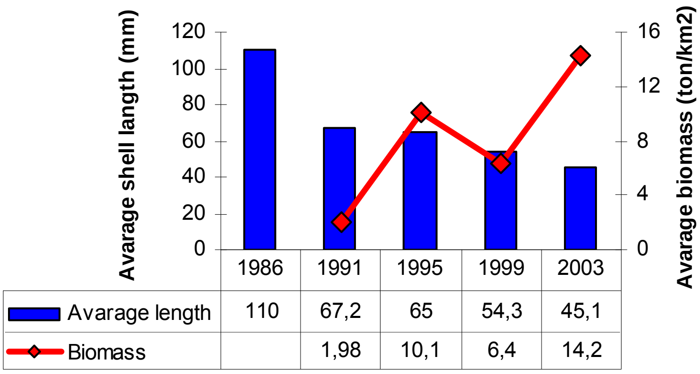


Figure 6.9.3.2.3. The relationship between the mean length and biomass of the Rapa whelk in south eastern Black Sea.

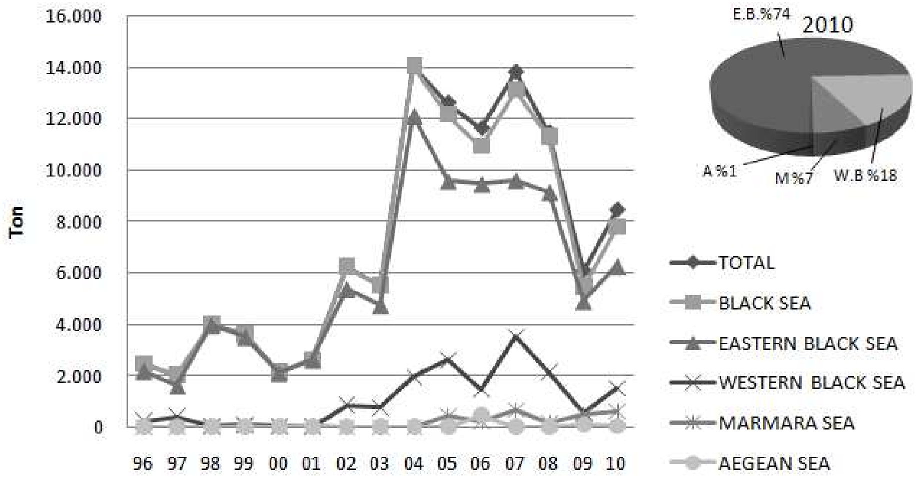


Figure 6.9.3.2.4. Catch of Rapana in different fishing areas in Turkey

According to the surveys carried out in the main fishing areas on the central part of Turkish coast in 2011, mean length, weight and width of 1704 specimens of Rapana were calculated as 56,8±0,36 mm, 45,7±0,89 g and 42,5±0,29 mm. Females have slightly higher values than males but the difference is not statistically significant. Length-weight relationship was derived as $W = 0.0006\ L^{2.719}$ for both sexes ($N=1704$, $R^2=0.826$). According to the statistical analyzes there is no difference between the regression coefficient of males and females. The relationship between length-width was found as $L_W=0.793L^{2.601}$ ($R^2 = 0.945$). On the other hand, there is also high correlation between weight and width of Rapana as $R^2=0.811$ in the equation of $W=0.004L_W^{2.437}$ (Sağlam, 2012 and Sağlam, 2013).

Mean weight is calculated as 60 mm ranging between 21 to 108 mm. On the other hand mean width and weights are 43 mm and 45g, respectively (Table 6.9.3.2.2.).

Table 6.9.3.2.2. Mean total length (mm), weight (g), width (mm) and relationships between length-weight, length-width and width-weight of *Rapana* population in the Central Black Sea in 2011 (±standard error, ranges in parenthesis) (Sağlam, 2012 and Sağlam, 2013).

	Female (N=791)	**Male (N=913)**	**Total (N=1704)**
	Mean	**Mean**	**Mean**
Total length (L) min-max	56.93±0.54 (21.00-107.88)	56.69±0.49 (21.00-102.95)	56.80±0.36 (21.00-107.88)
Witdh (Lw) min-max	42.49±0.44 (13.00-83.54)	42.44±0.40 (13.00-81.13)	42.47±0.29 (13.00-83.54)
Weight (W) min-max	45.11±1.34 (1.23-269.20)	45.93±1.20 (1.28-269.20)	45.67±0.89 (1.23-269.20)
L-Lw	$L_W = 0.787L - 2.333$	$L_W = 0.799L - 2.851$	$L_W = 0.793L - 2.601$
	$R^2 = 0.943$	$R^2 = 0.947$	$R^2 = 0.945$
L-W	$W = 0.0005L^{2.7714}$	$W = 0.0007L^{2.7038}$	$W = 0.0006L^{2.719}$
	$R^2 = 0.8510$	$R^2 = 0.8230$	$R^2 = 0.826$
Lw-W	$W = 0.003L_W^{2.484}$	$W = 0.004L_W^{2.397}$	$W = 0.004L_W^{2.437}$
	$R^2 = 0.824$	$R^2 = 0.800$	$R^2 = 0.811$

Monthly changes in size is given in Table 6.9.3.2.3.

Table 6.9.3.2.3. Mean length, weight, width (± standart error) and sex rate of Rapana by months

	N	**Length**	**Weight**	**Width**	**Sex ratio (%)**
			Female		
June 10	136	66.48±1.40	61.84±3.83	52.37±1.15	7.98
July 10	113	58.34±1.47	67.96±4.39	42.56±1.10	6.63
Aug 10	102	54.50±0.58	36.91±1.16	43.00±0.49	5.99
Sept 10	138	61.50±1.15	42.30±2.23	45.01±0.85	8.10
Oct 10	146	46.75±1.00	19.64±1.45	34.06±0.76	8.57
Nov 10	156	54.65±1.21	46.93±3.28	39.17±1.00	9.15
Total	791	56.93±0.54	45.36±1.34	42.49±0.44	46.42
			Male		
June 10	158	65.11±1.21	57.60±3.24	51.45±1.03	9.27
July 10	137	57.28±1.28	69.15±3.72	42.05±1.00	8.04
Aug 10	125	54.66±0.52	37.78±1.05	42.82±0.44	7.34
Sept 10	150	63.22±1.21	47.48±2.79	46.31±0.93	8.80
Oct 10	160	47.79±0.99	21.54±1.64	35.24±0.78	9.39
Nov 10	183	52.80±1.04	44.11±2.52	37.84±0.84	10.74
Total	913	56.69±0.49	45.93±1.20	42.44±0.40	53.58
			Total		
June 10	294	65.74±0.91	59.56±2.48	51.87±0.76	17.25
July 10	250	57.76±0.96	68.61±2.84	42.28±0.74	14.67
Aug 10	227	54.59±0.39	37.39±0.78	42.90±0.33	13.32
Sept 10	288	62.40±0.84	45.00±1.81	45.69±0.63	16.90
Oct 10	306	47.29±0.70	20.63±1.10	34.68±0.55	17.96
Nov 10	339	53.65±0.79	45.41±2.03	38.45±0.65	19.89
Total	1704	56.80±0.36	45.67±0.89	42.47±0.29	100.00

According to the historical data and long term observations, mean size of Rapana has decreased due to lack of prey in the South-eastern Black Sea except in the area of Samsun province (mainly off Terme town). Majority of licenced vessels operates dredging in that area.

6.9.4 *Short term prediction of stock biomass and catch*

Given the data available the EWG did not perform a short term prediction of stock size and catches under various management options. Age based assessments can not be done due to aging is not satisfactory to reflect variations in growth. Length based assessments can not be applied due to uncertainties in the existing length frequencies by months which are not permitting the growth of cohorts.

6.9.5 *Medium term prediction of stock biomass and catch*

The WG did not undertake medium term projections.

6.9.6 *Long term predictions*

EWG 13-12 did was not able to run long term predictions with the existing data.

6.9.7 *Scientific advice*

6.9.7.1 Short term considerations

State of the spawning stock size:

Given the status of the data and assessment the EWG 13-12 is unable to provide scientific advice.

State of recruitment:

Given the status of the data and assessment the EWG 13-12 is unable to provide scientific advice.

State of exploitation:

Given the status of the data and assessment the EWG 13-12 is unable to provide scientific advice.

6.9.7.2 Medium term considerations

Given the status of the data and assessment the EWG 13-12 is unable to provide scientific advice for the management of Rapana stocks. But some recommendations can be done for the better understanding the state of the stocks as well as their management:

- Rapana should be included under Data Collection Framework of EU in the Black Sea,
- In case of other countries, GFCM should be effective on to recommend member countries and non members to add this species in their data collection programs
- Trainings is needed for age determination of Rapana,

Stock identification is needed in order to be able to make assessments for the whole Black Sea.

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8 APPENDIX 1. EXPLORATION ANALYSIS OF TURBOT STOCK ASSESSMENT

After careful examination of the model diagnostics, the working group considered to constrain the estimation of the fishing mortality for the oldest age groups (age 8+) to provide a sound estimation of the correlation parameter in the random walk on F. This resulted in a sensible improvement in the model stability and suggested the use of additional coupling in some of the catch-related variance parameters (Section 6.2.4.1.3; Results). Estimation of all the parameters and their associated uncertainty has also been largely improved – i.e. more stable uncertainty estimate in the final run (as well as in the retrospective analysis (Figure 1.6), no cross-correlation among the parameter estimates (Figure 1.7). Thus, the revised settings have been used throughout this assessment.

The catches have in general the smallest observation variance estimated with the exception of age 10+. These are followed by the different survey indices, with the ages 8-9 of the Romanian survey and the ages of the Ukrainian East survey as the less relevant surveys and the Ukrainian West, the ages 6-7 of the Bulgarian and the ages 4-7 of the Romanian survey as the most relevant surveys for this assessment (Figure 1.1).

Inspection of the residuals for the catch shows a good fitting of the catch-at-age matrix. The catch residuals are very small and generally free from patterns over time and ages (Figure 1.3 and 1.5). The residuals of the surveys show a general good fitting for all surveys except for the last 3 years of the Romanian survey and the Turkish commercial fleet, which are larger and smaller than the model estimates for the Romanian and Turkish commercial fleet, respectively. Year effects are generally more problematic than age effects with the assessment model used, as temporally-invariant parameters have been adopted. Overall, the agreement between the data and the fitted model appears good throughout the data sources which are most influential in the model.

Estimation of the selectivity pattern shows an increase in the selectivity with age; the model was constrained to have same selectivity for age 8+. The selection pattern is relatively stable until 1970´s but shows a decline in the selectivity at age for the older fish between 1975´s and 1985´s and a successive increase from 1990´s and onwards (Figure 1.2).

The estimated surveys catchability shows a similar pattern for the surveys, with a decline for the older ages, except for the Romanian survey, which shows a decreasing catchability with age (Figure 1.4).

Retrospective analysis suggests that the assessment method gives a consistent perception of the stock and its dynamics (Figure 1.6). A stable uncertainty associated to the model parameters was estimated for all the retrospective runs. The uncertainty of the estimated values for the main stock parameters is generally lower than 0.3 (Figure 1.8). The retrospective runs consistently overestimate SSB and recruitment but has no particular trend in fishing mortality.

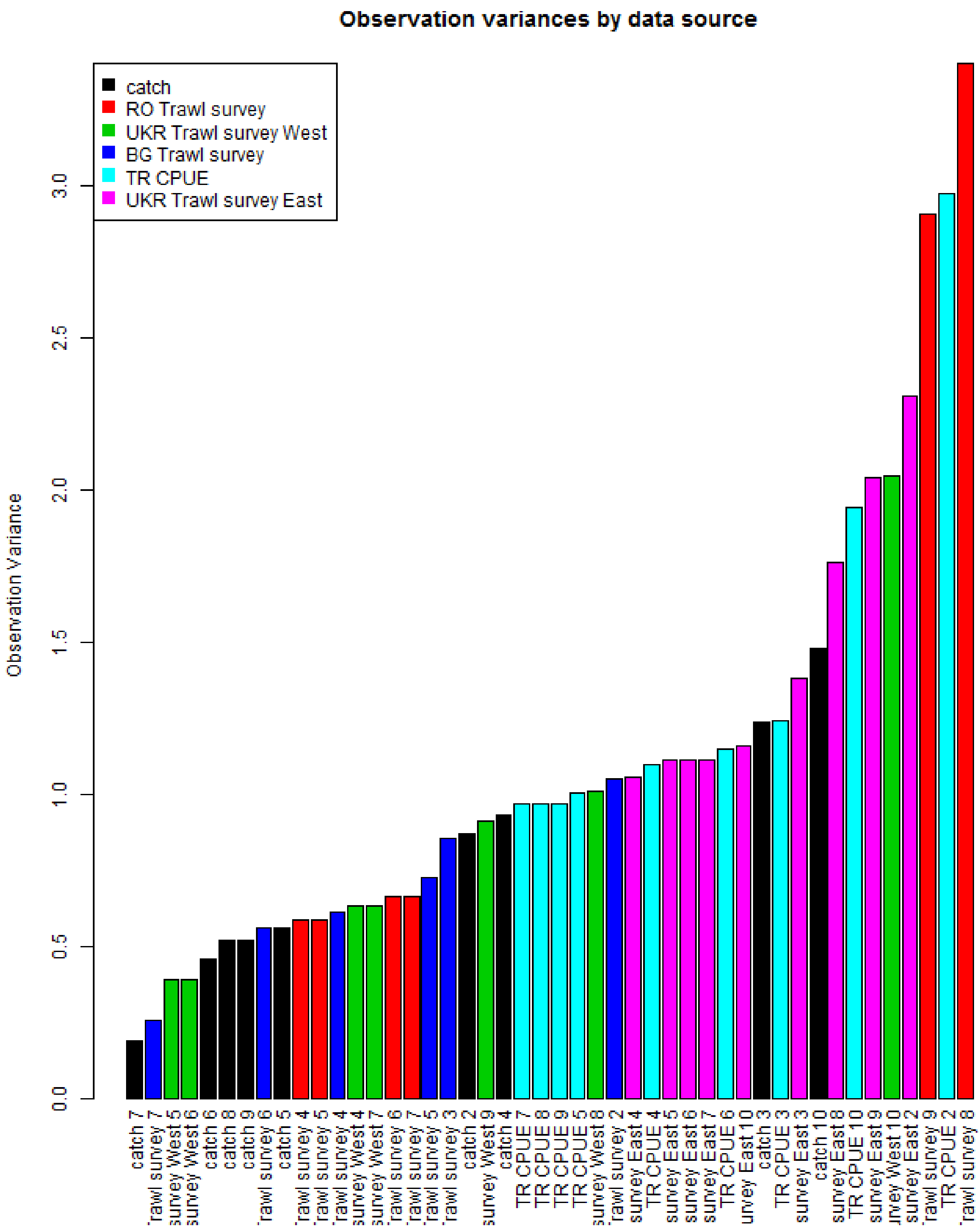


Figure 1.1.Black Sea turbot. Estimated observation variance for the final assessment.

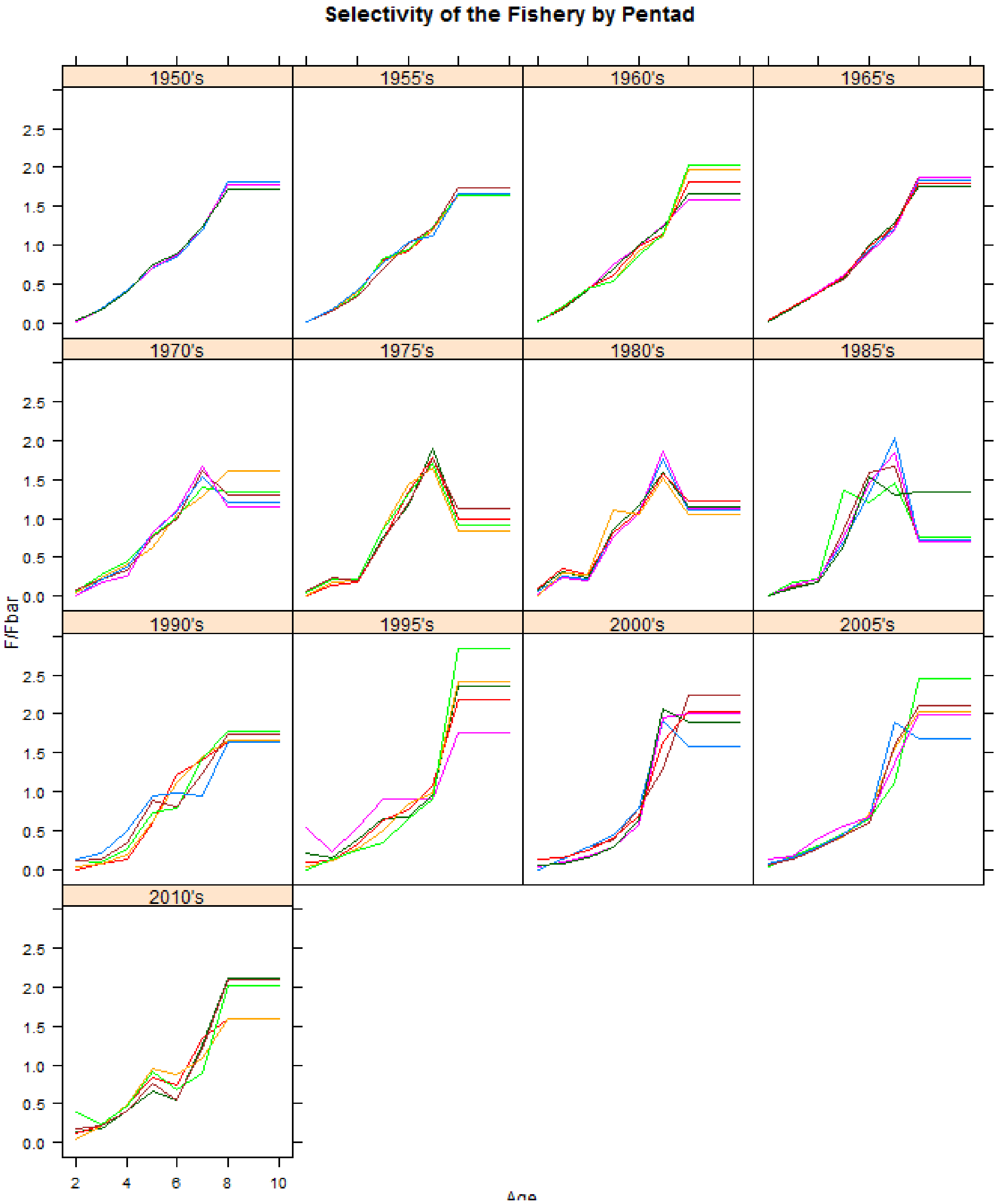


Figure 1.2.Black Sea turbot. Final run. Estimated selection pattern at age of the fisheries for the whole time period of the assessment.

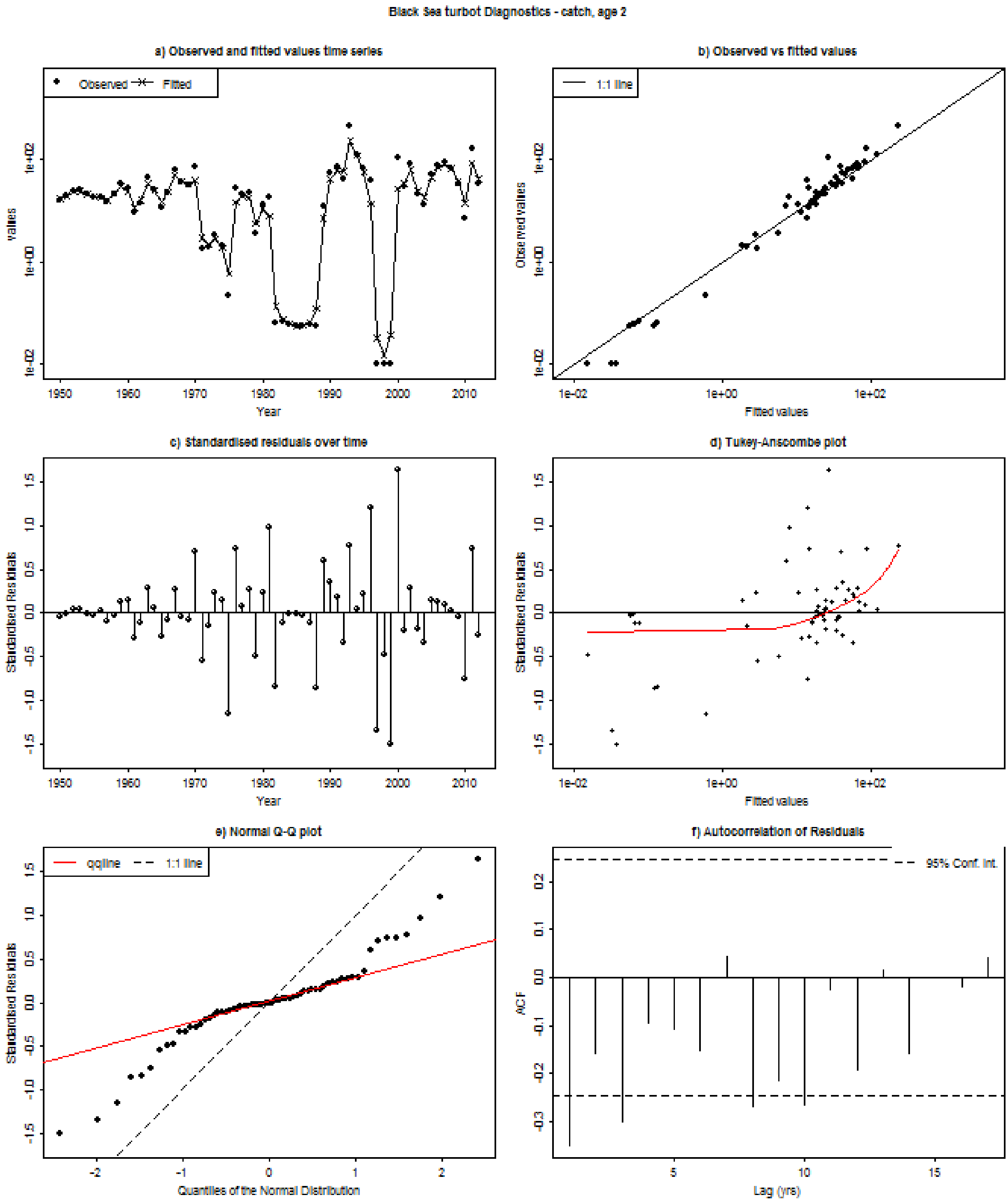
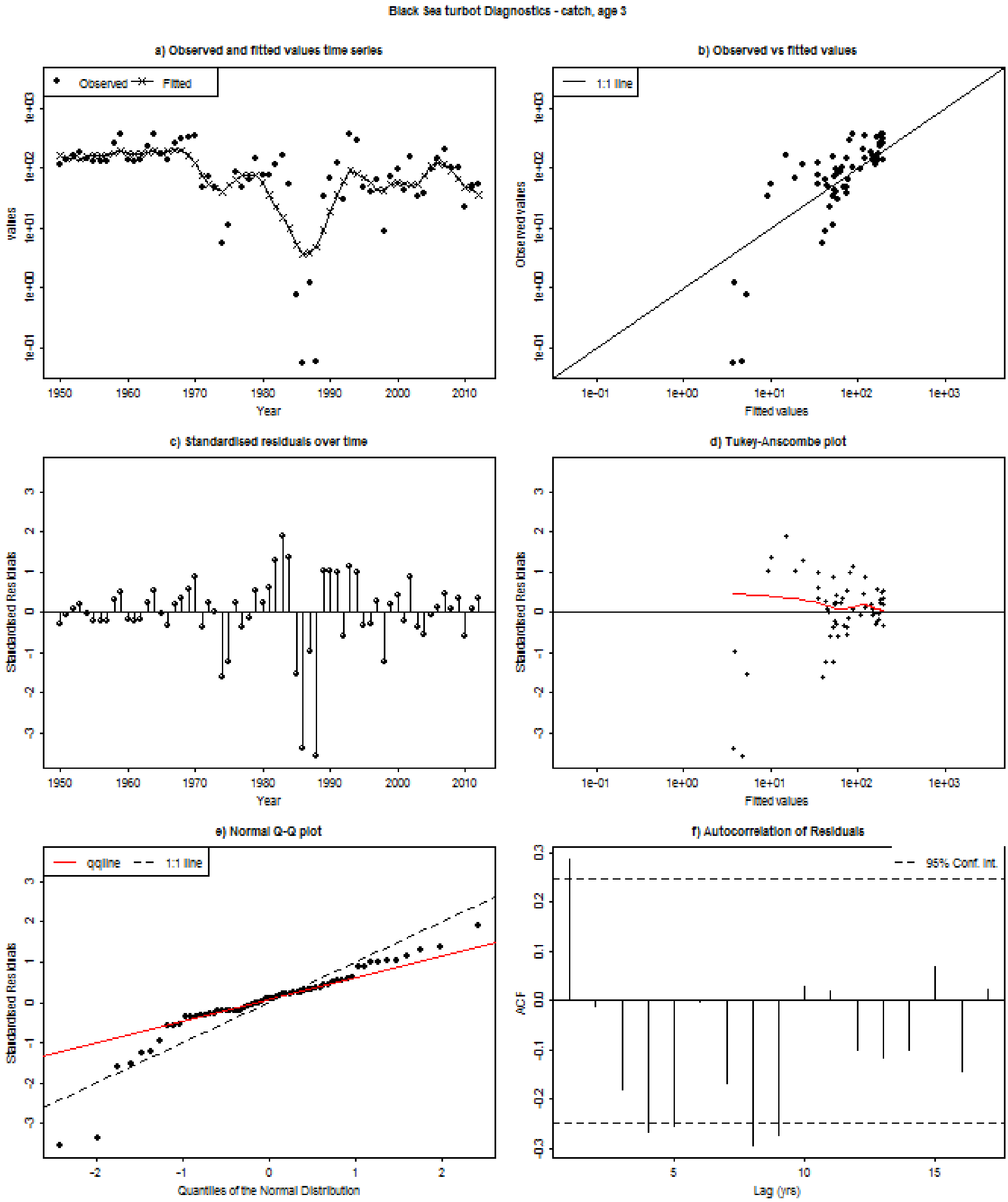
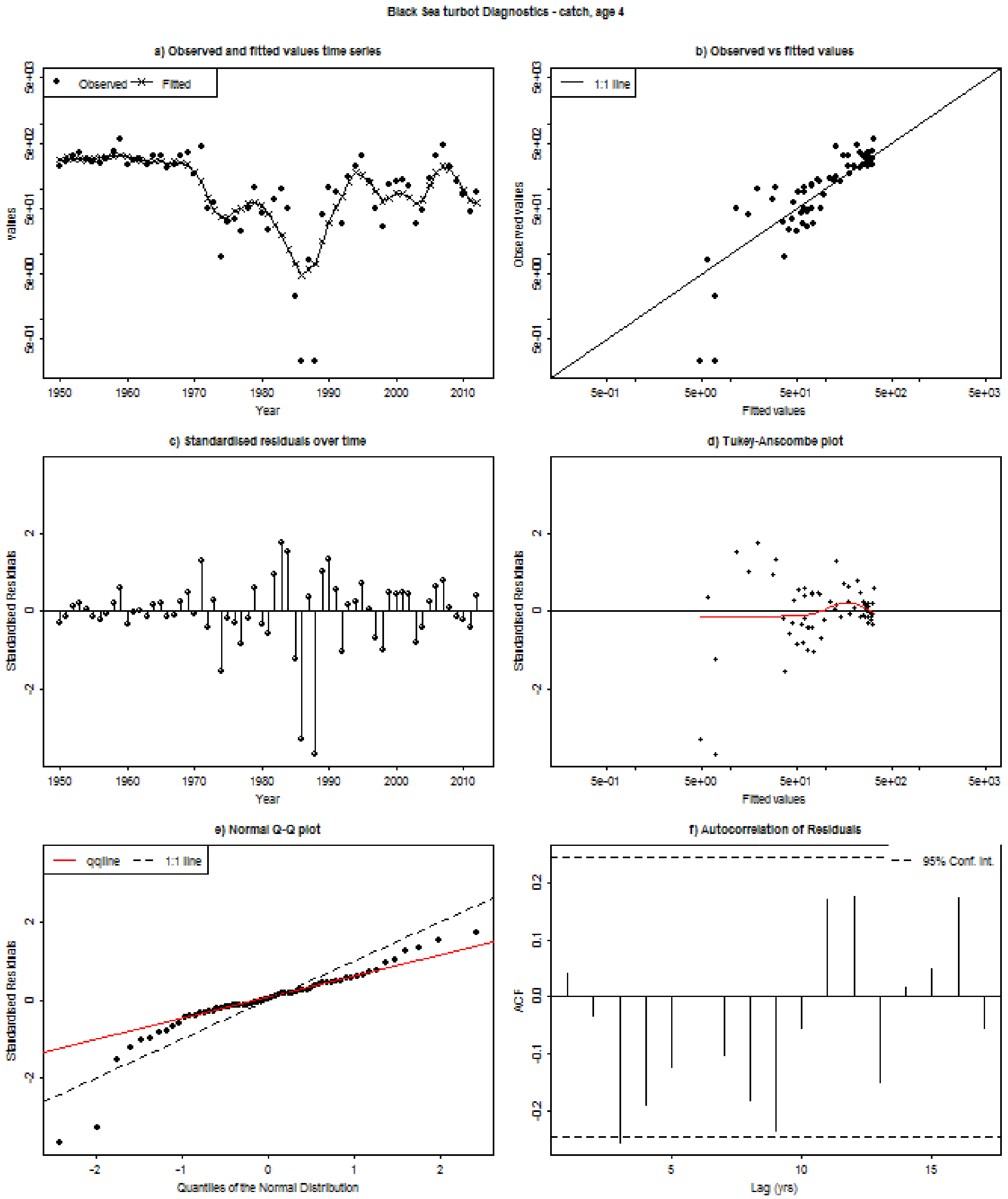


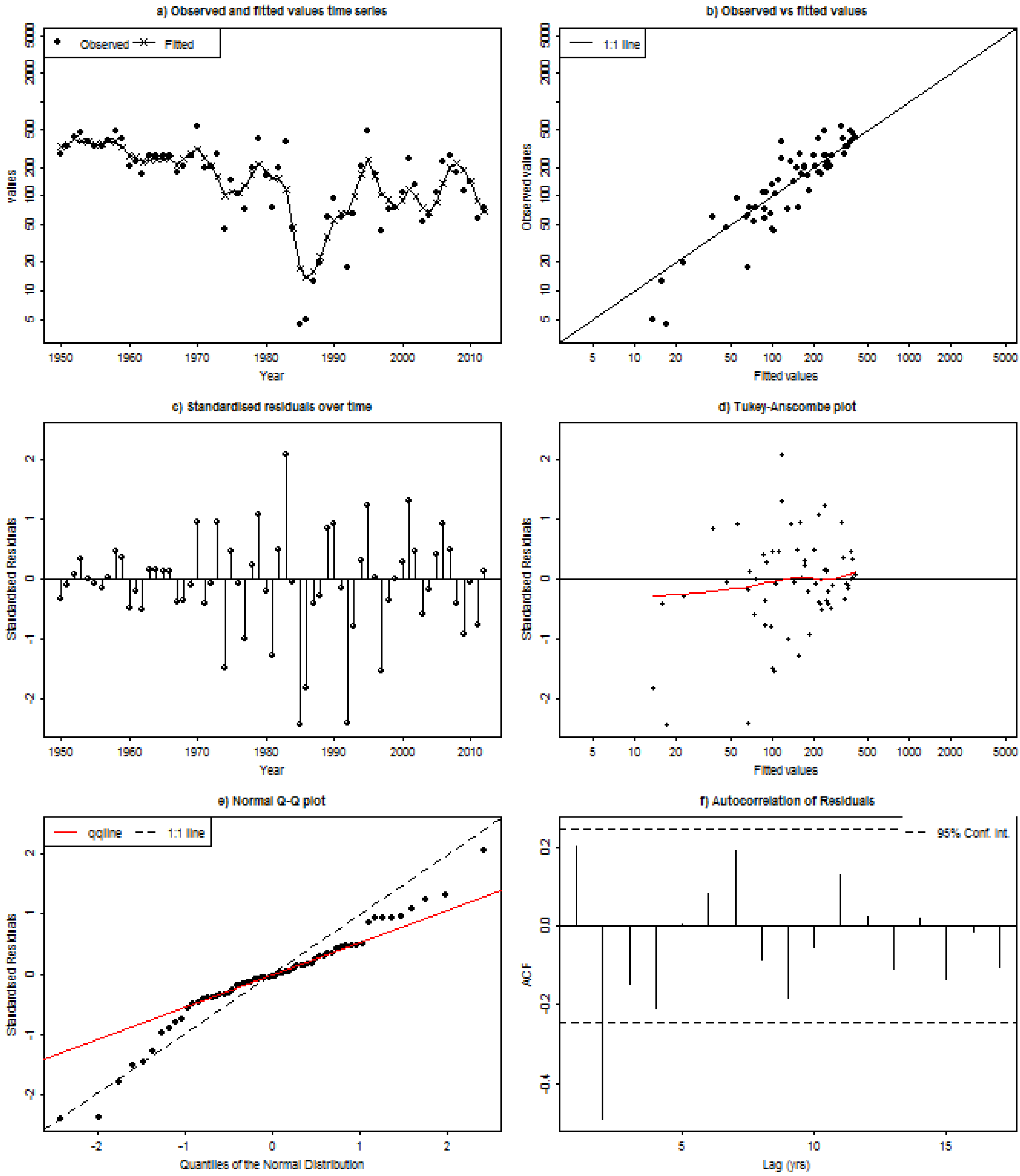
Figure 1.3.Black Sea turbot. Final run. Diagnos-tics of the commercial catches and survey indices fit from the assessment. a) Comparison of observed (points) and fitted (line) index value. b) Scatterplot of index observations versus model estimates of stock numbers at age. Fitted catchability (linear model – solid line), with 95% confidence interval (dot-ted line). c) Log siduals of catchability model fitted by the model as a function of time. d). Log residuals from the catchability model against the estimated stock size at age. e). Normal Q-Q plot

of log residuals (points) with fitted linear regression (solid line) and 90% confidence interval for predication (dotted line).

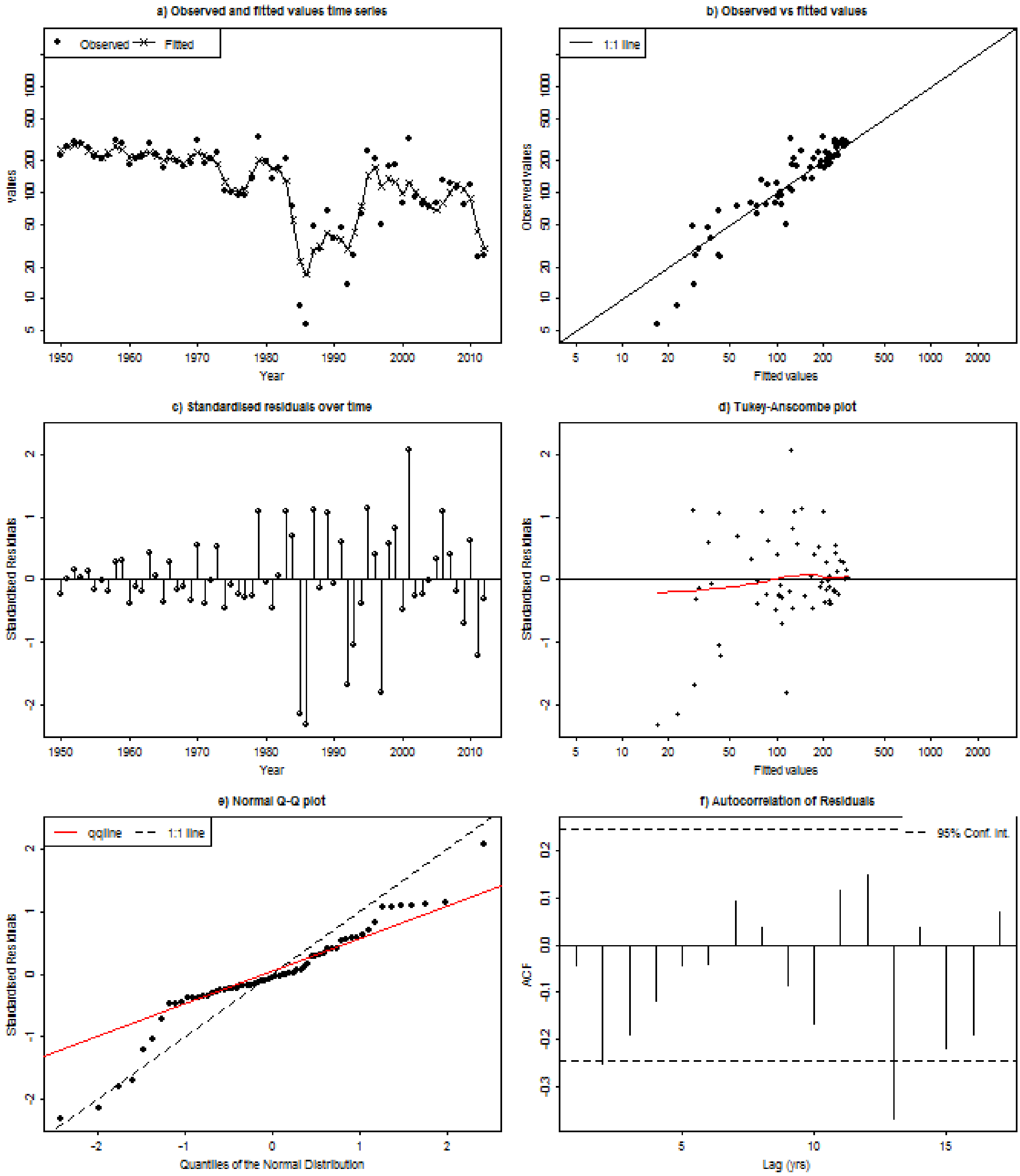


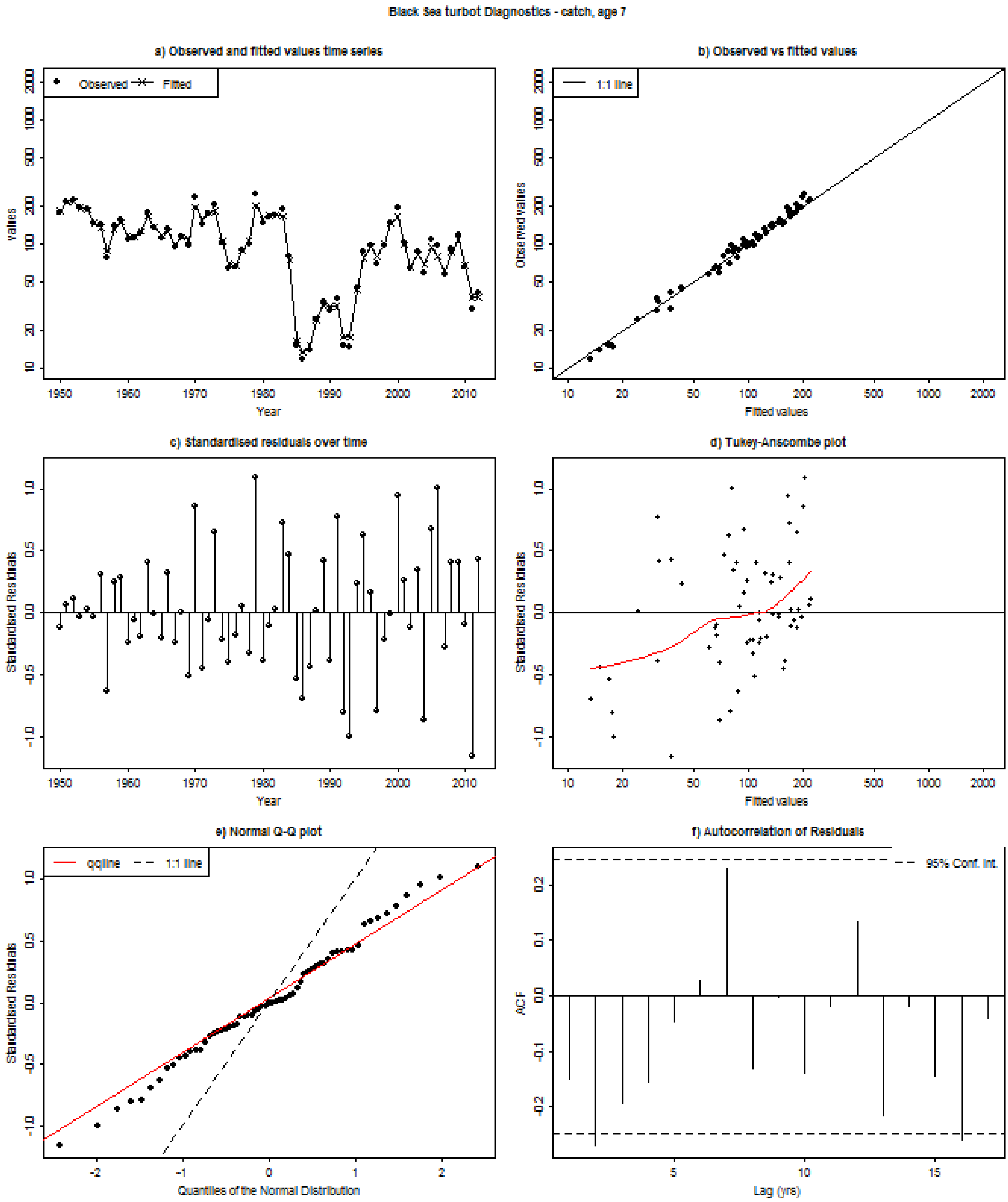

Black Sea turbot Diagnostics - catch, age 4
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

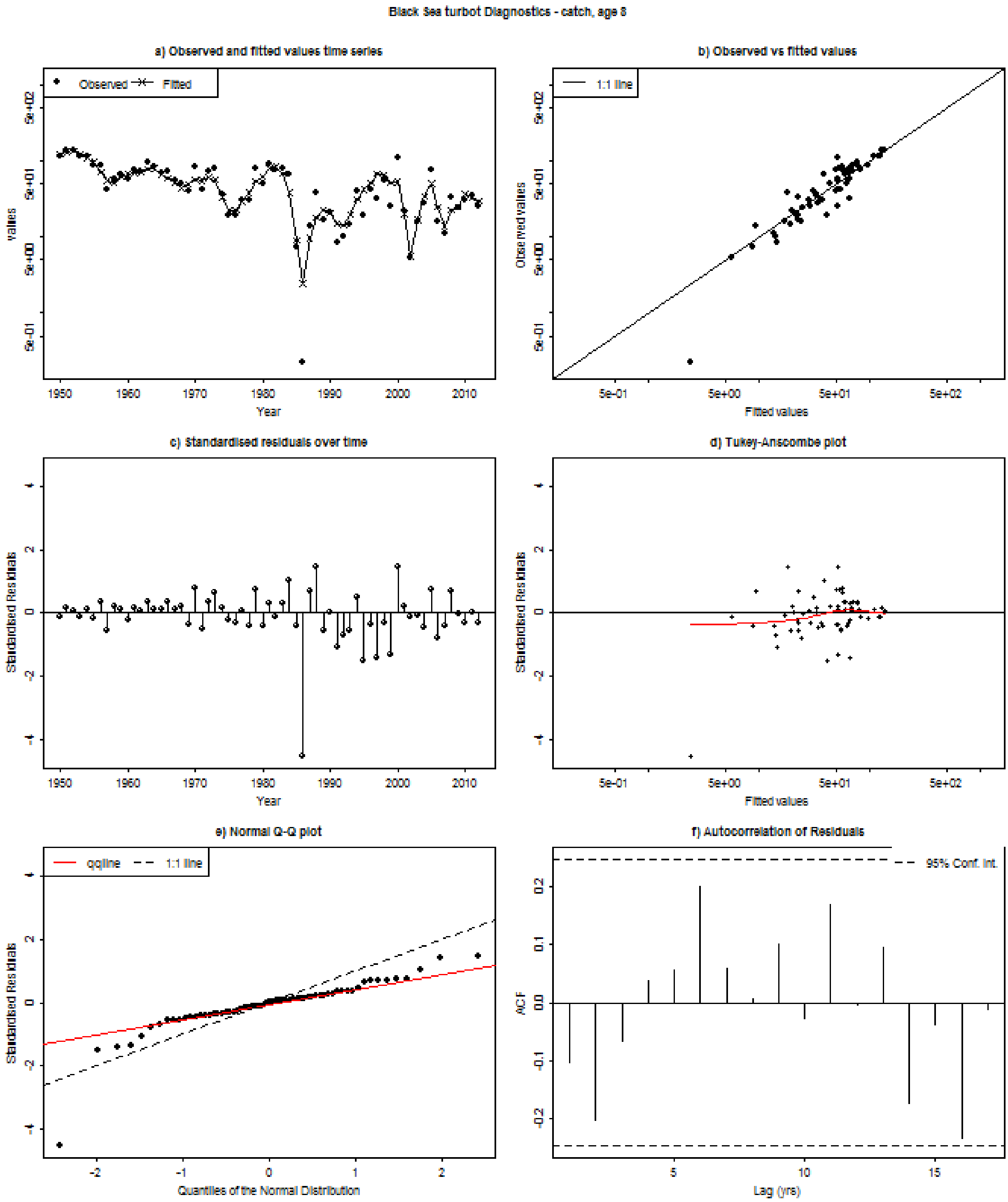
Black Sea turbot Diagnostics - catch, age 5



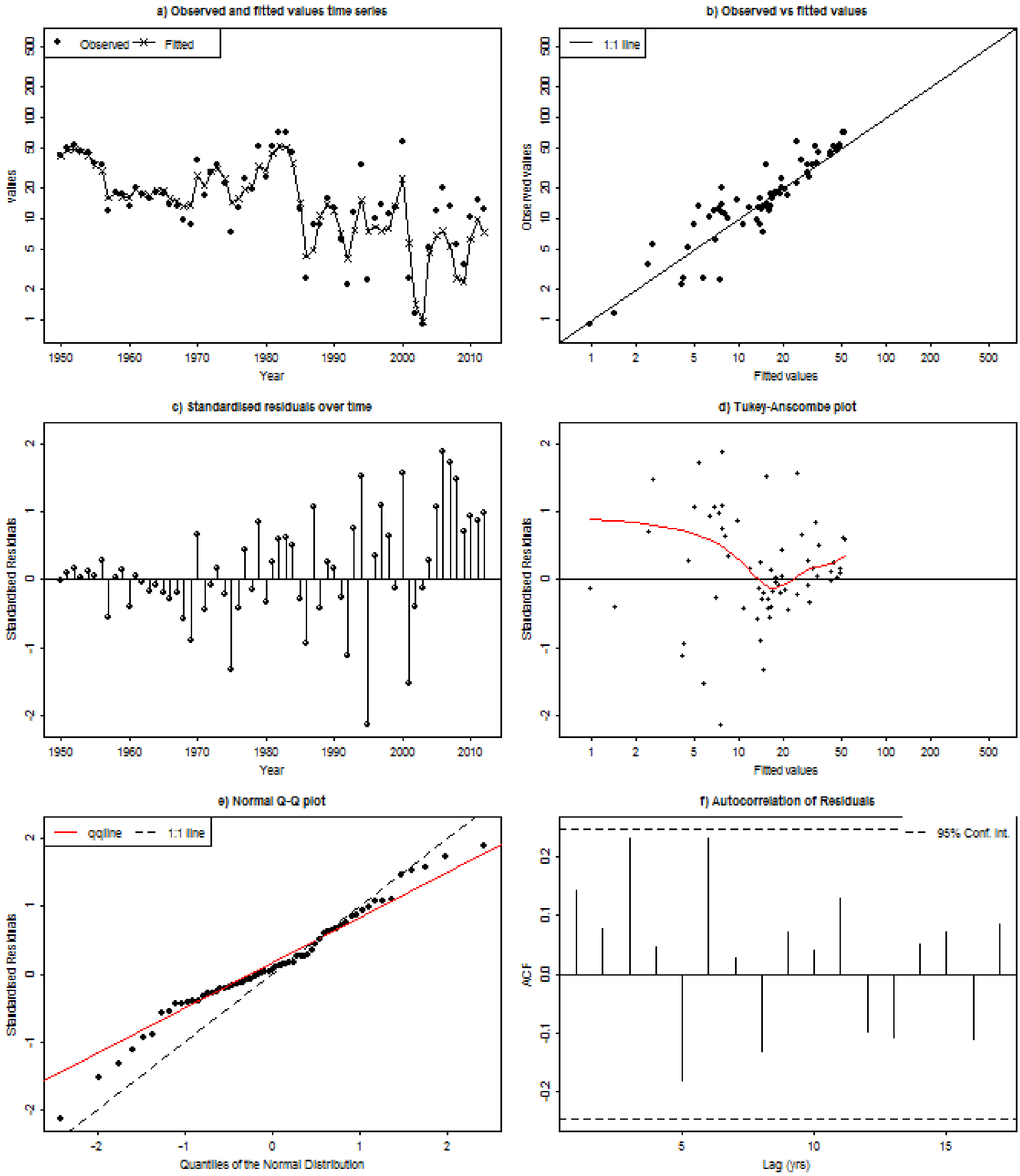
Black Sea turbot Diagnostics - catch, age 6

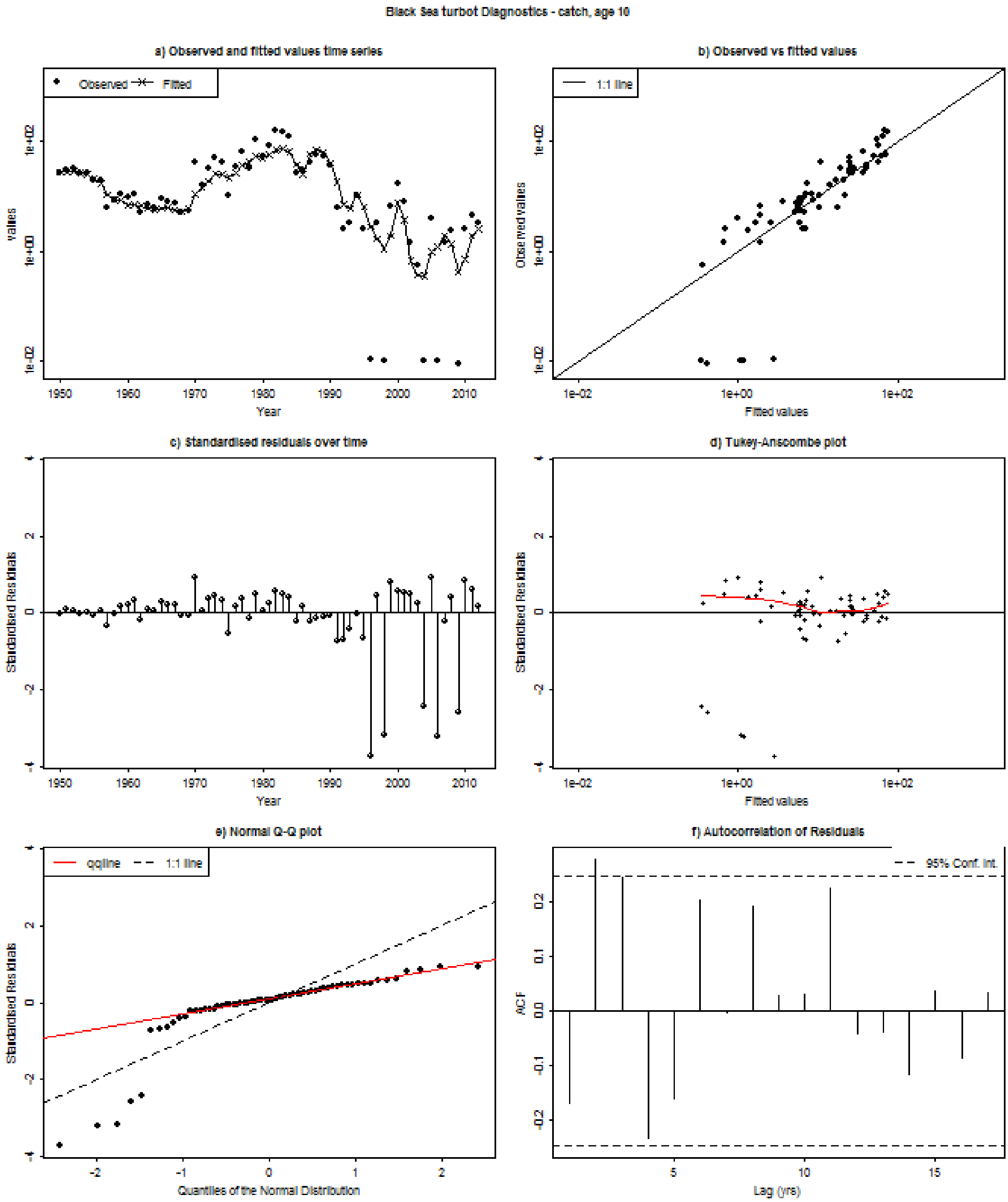


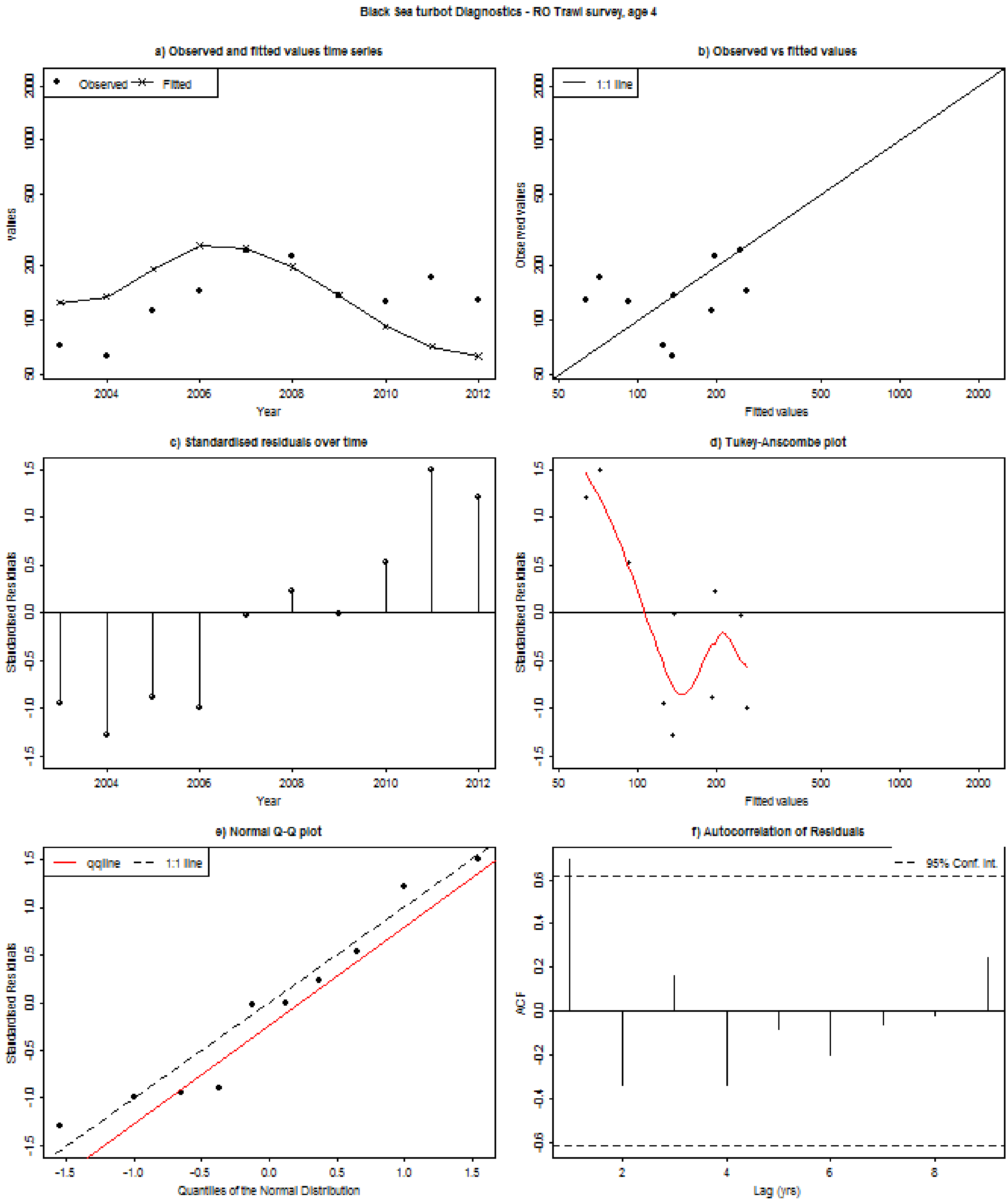

Black Sea turbot Diagnostics - catch, age 7
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)


Black Sea turbot Diagnostics - catch, age 8
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

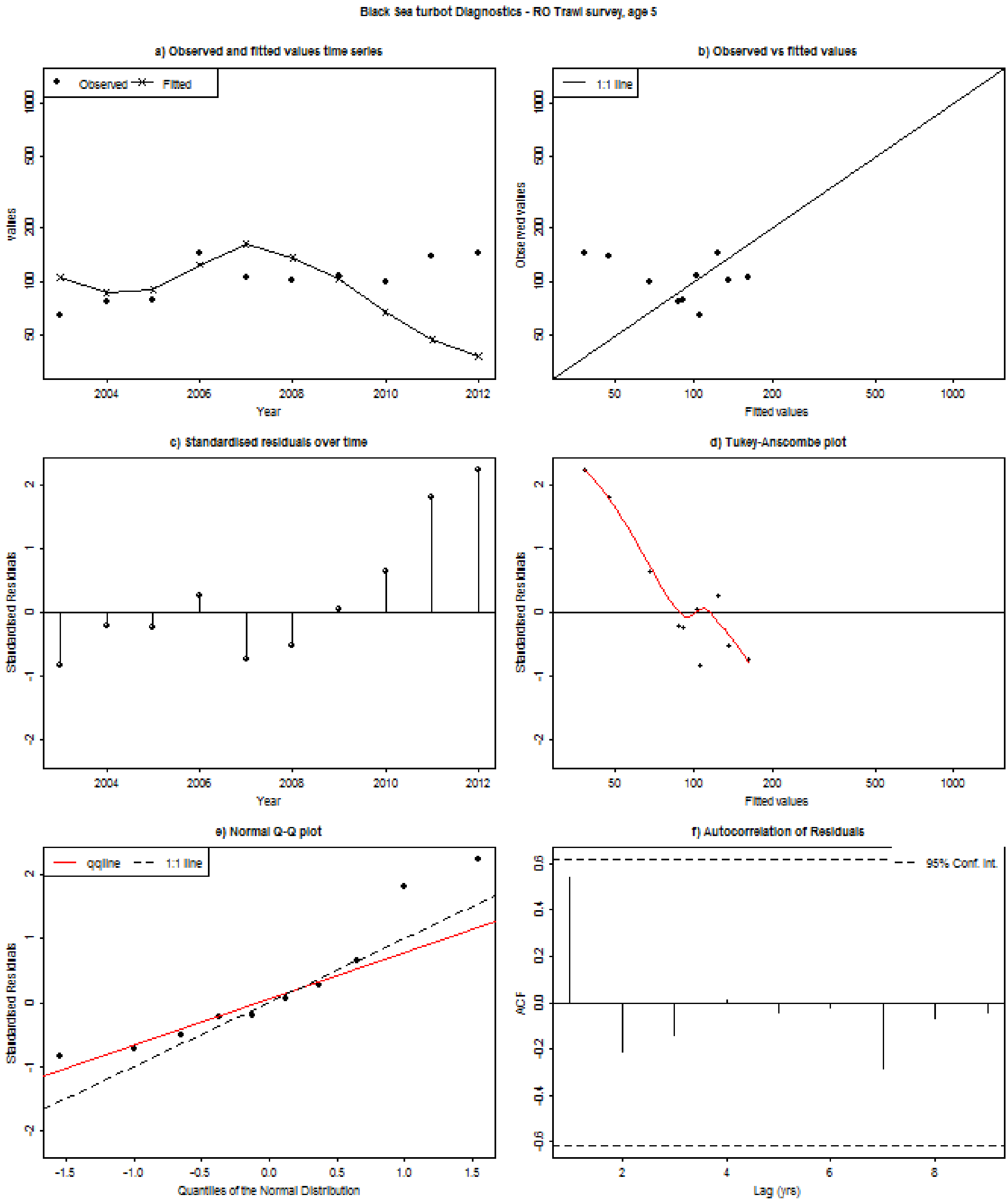
Black Sea turbot Diagnostics - catch, age 9

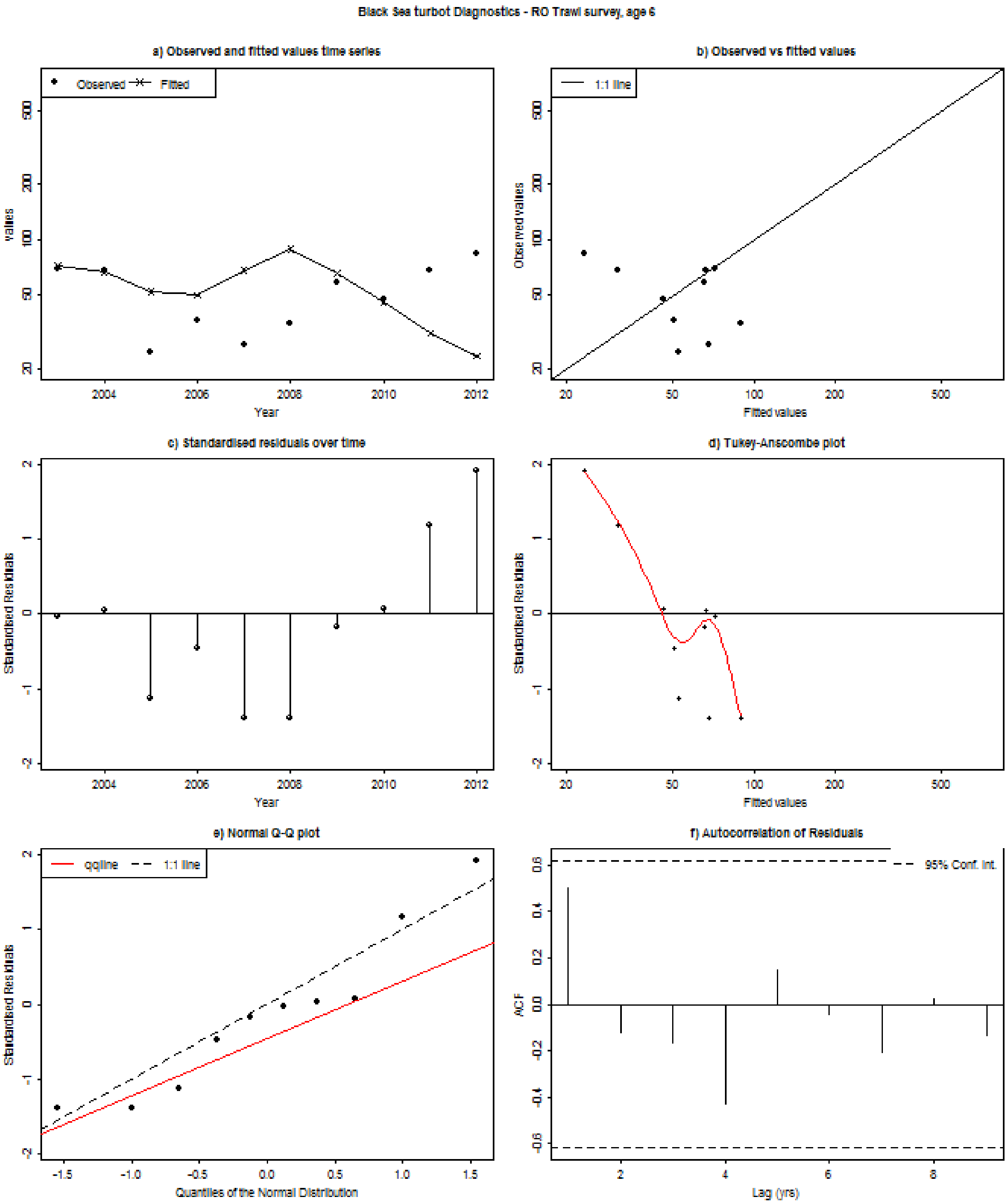



Black Sea turbot Diagnostics - catch, age 10
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

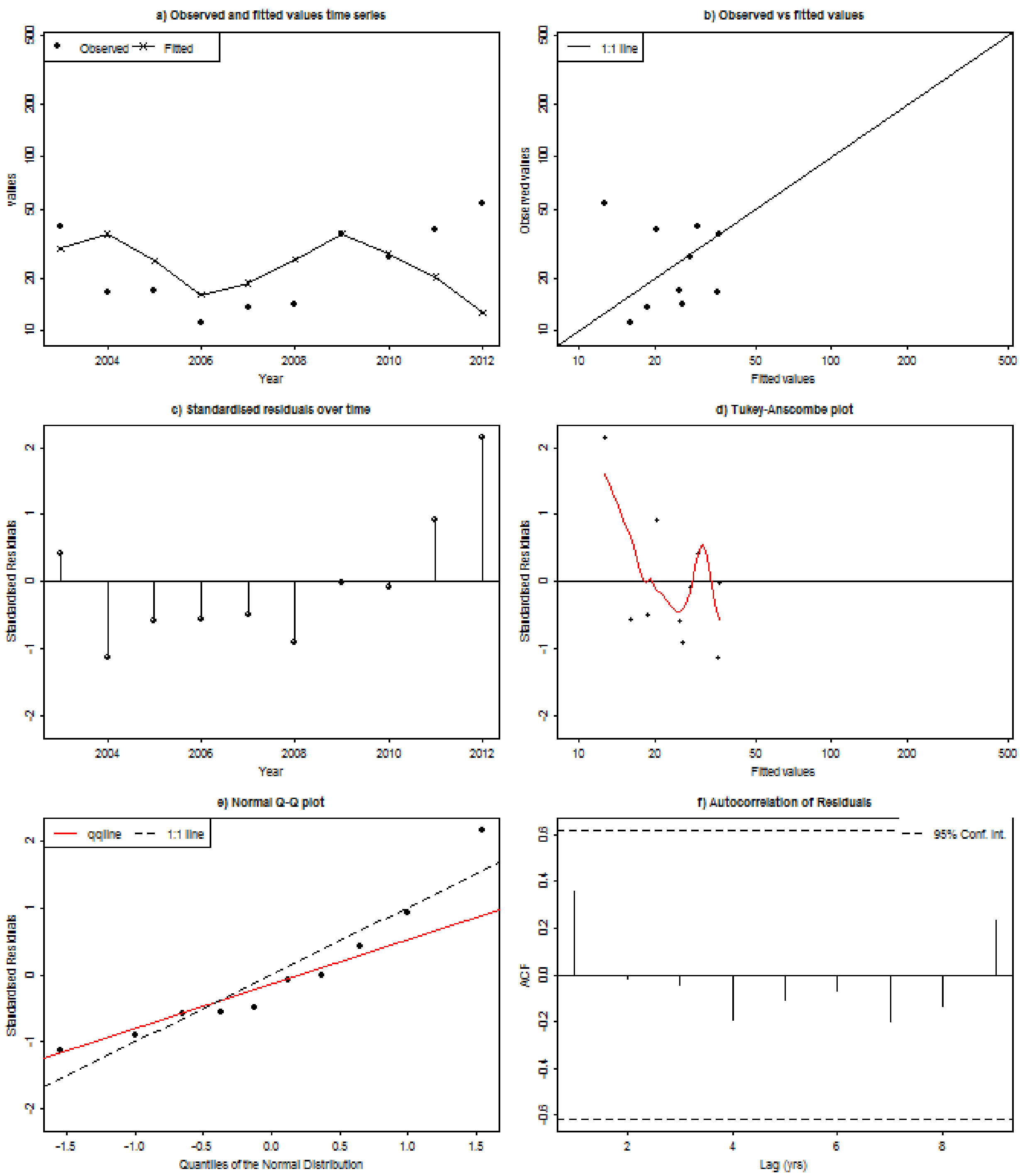


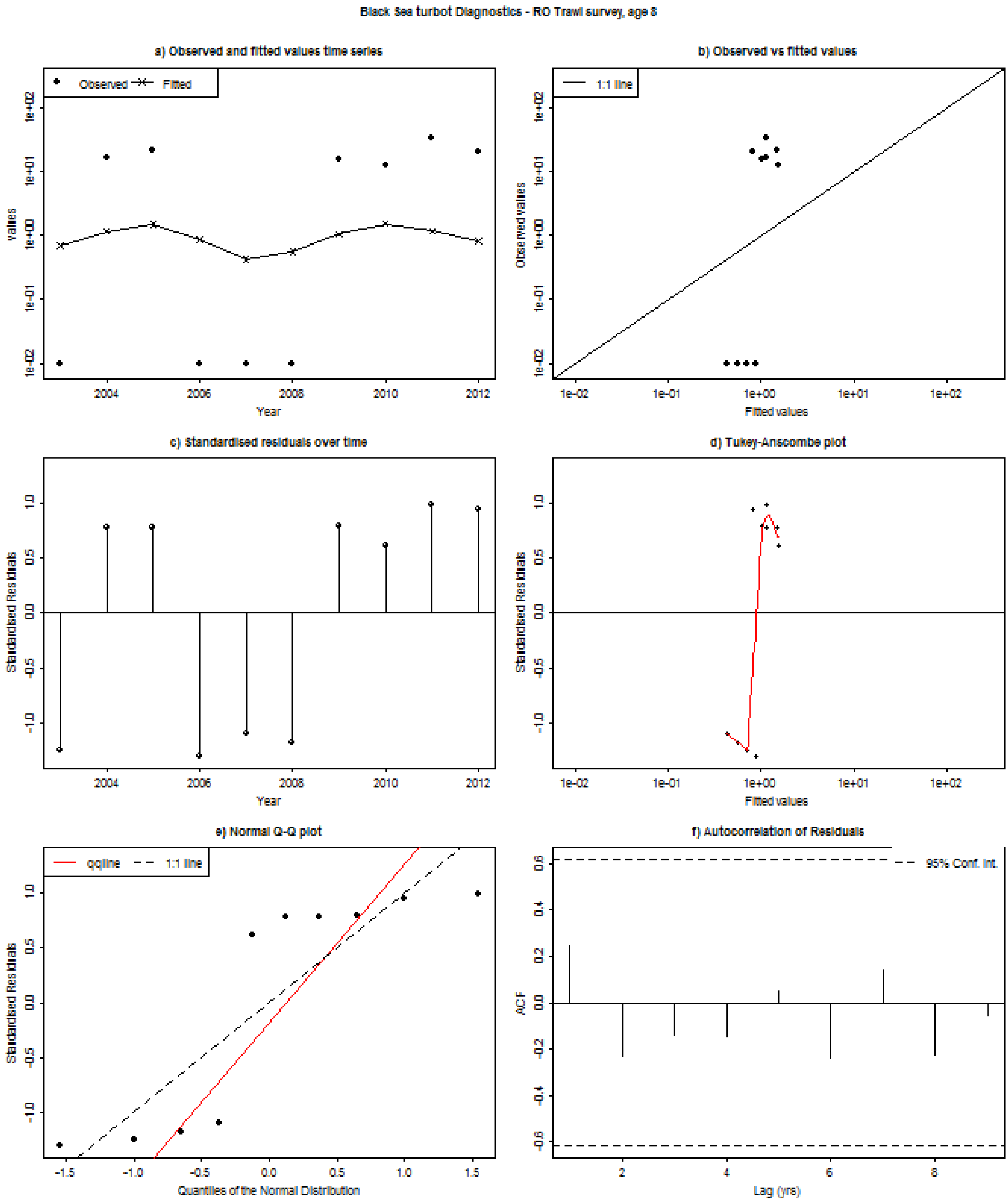
Black Sea turbot Diagnostics - RO Trawl survey, age 4
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

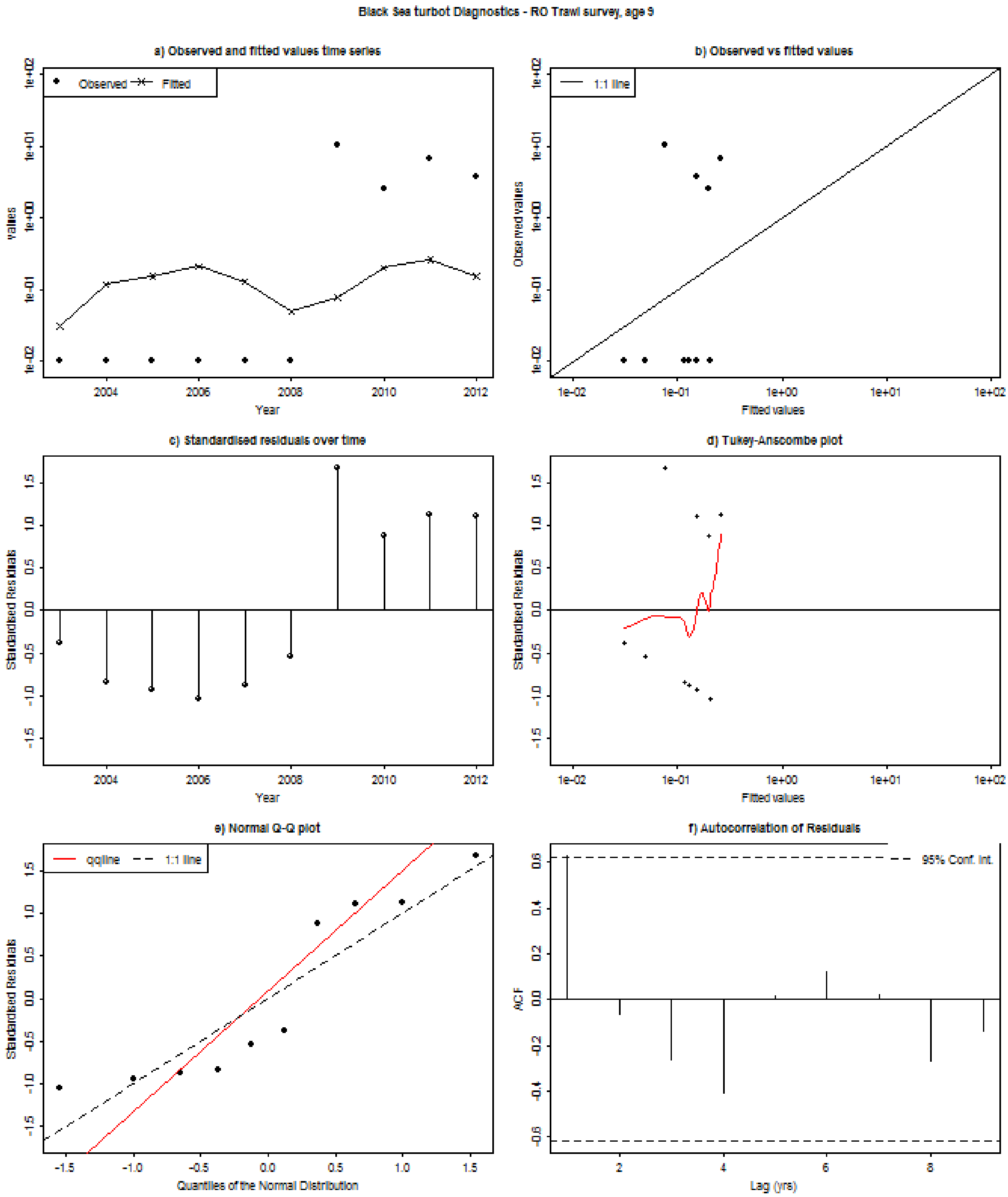

Black Sea turbot Diagnostics - RO Trawl survey, age 5
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)


Black Sea turbot Diagnostics - RO Trawl survey, age 6
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

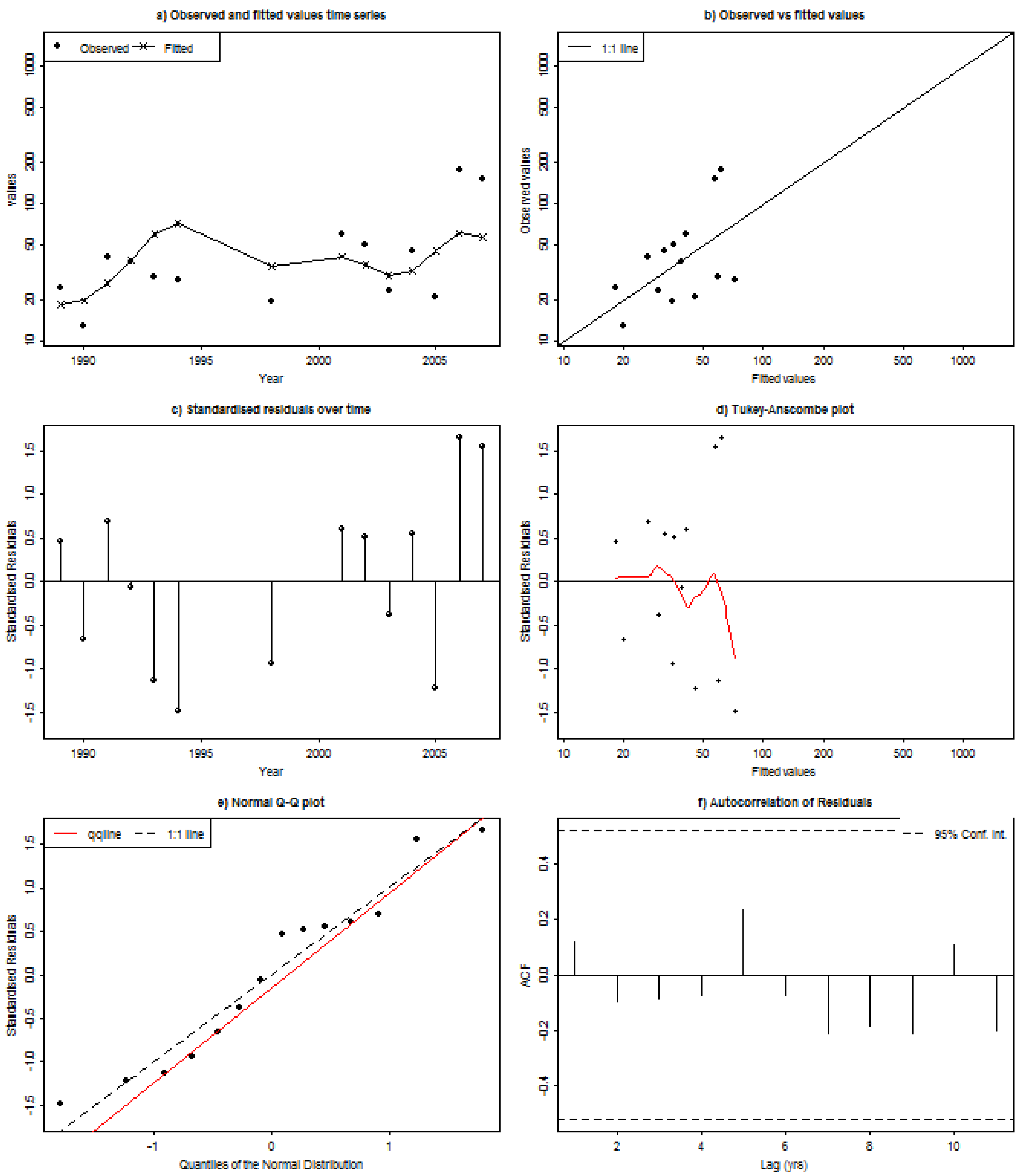
Black Sea turbot Diagnostics - RO Trawl survey, age 7

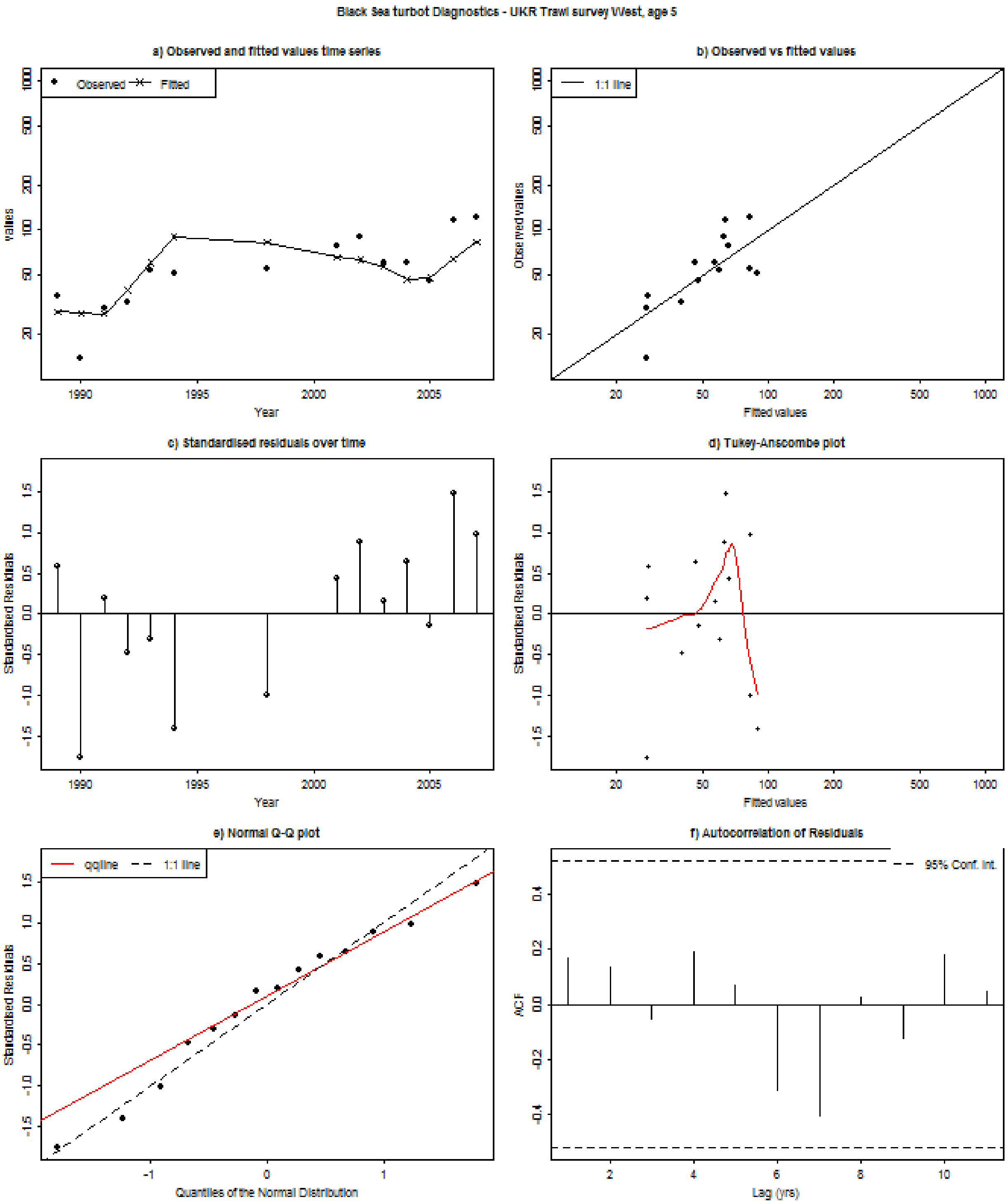



Black Sea turbot Diagnostics - RO Trawl survey, age 8
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

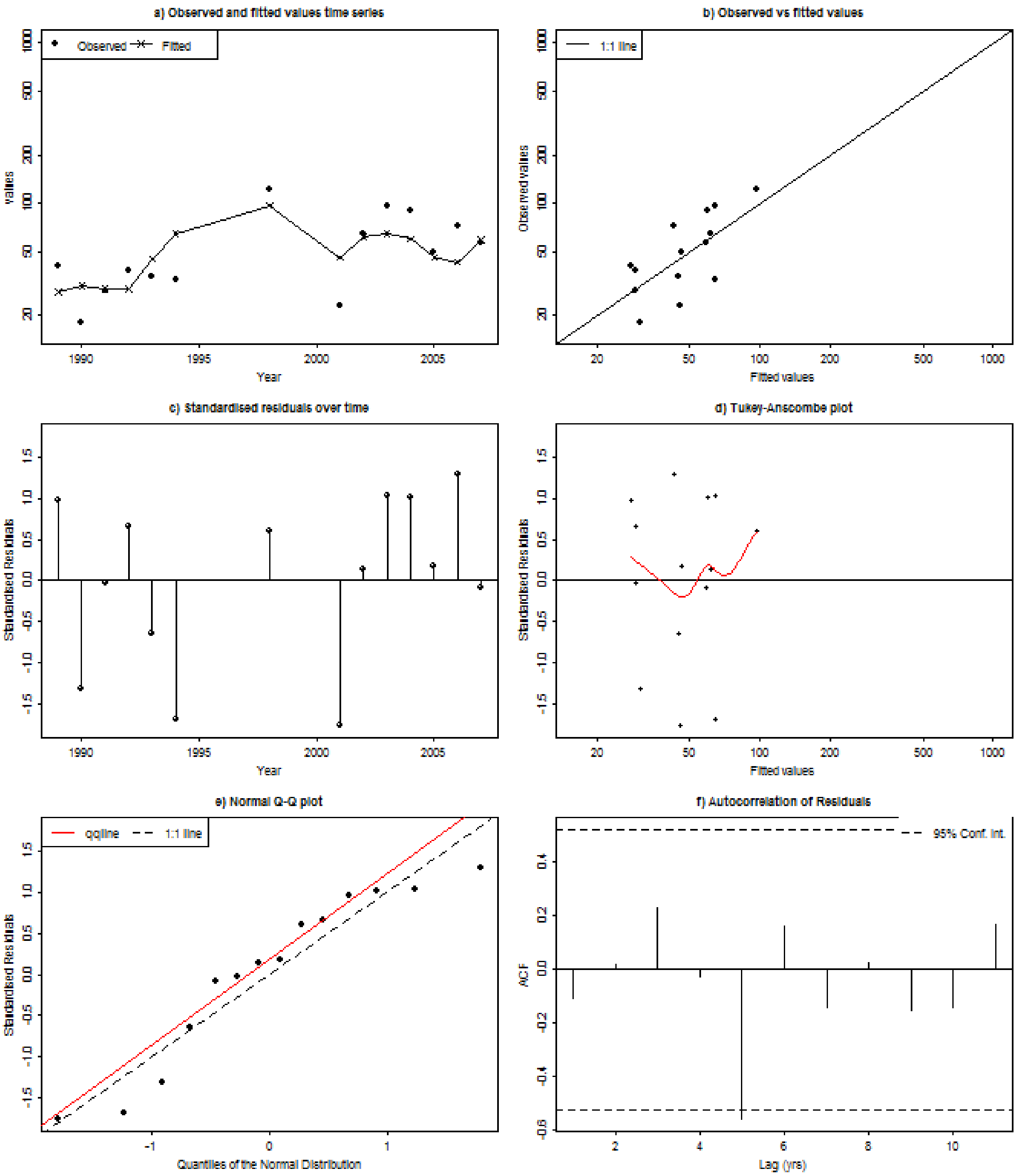

Black Sea turbot Diagnostics - RO Trawl survey, age 9
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

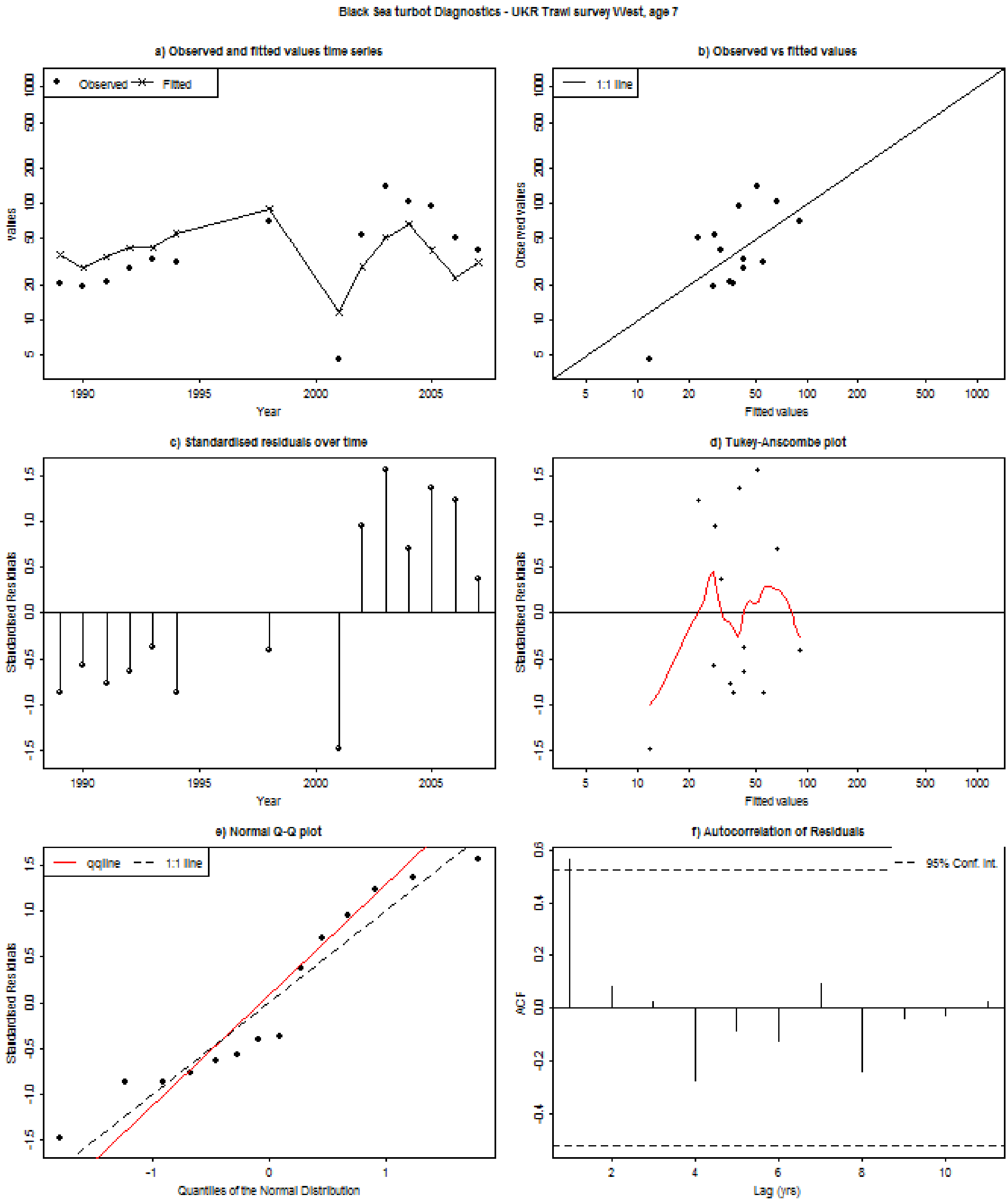
Black Sea turbot Diagnostics - UKR Trawl survey West, age 4

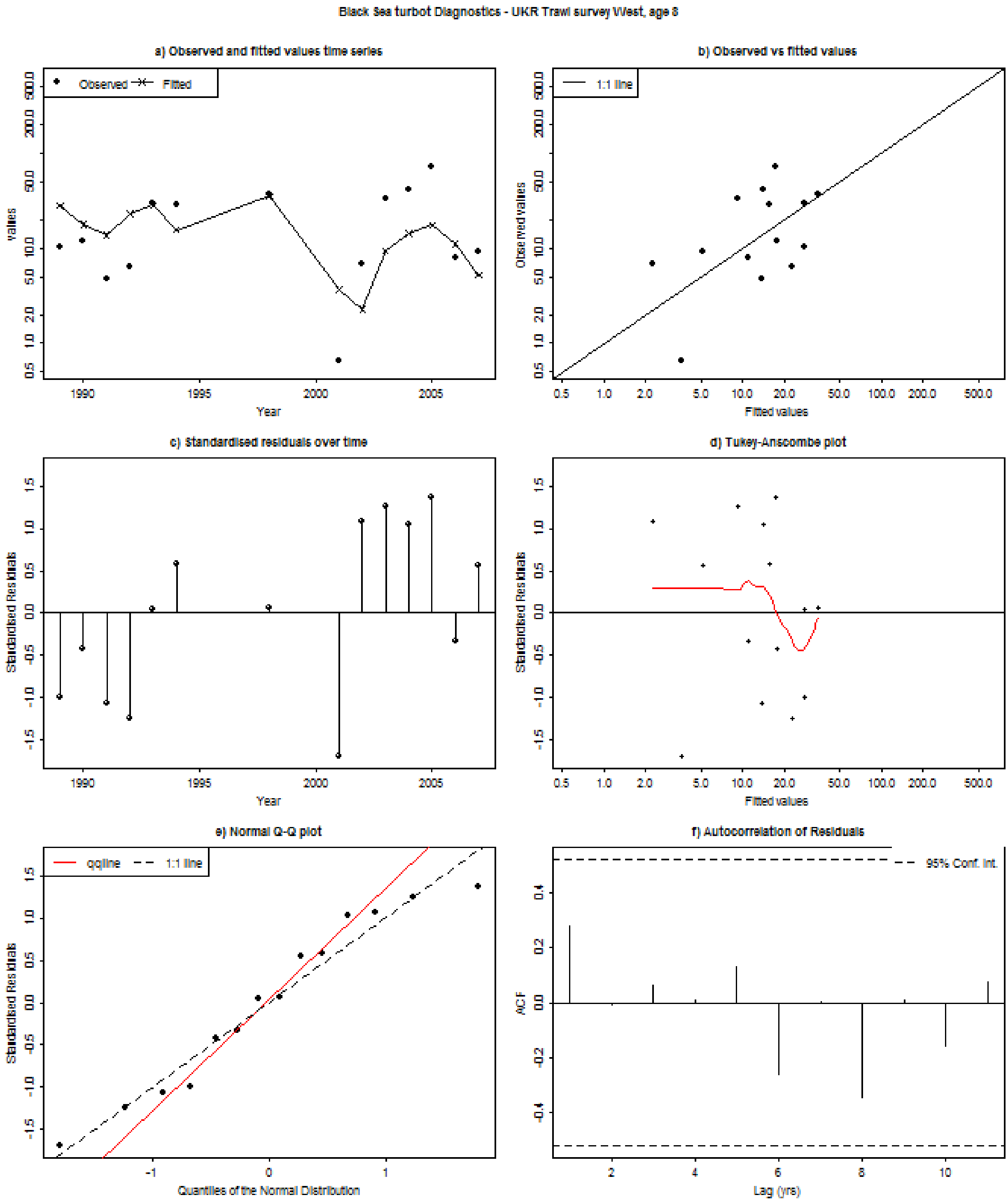



Black Sea turbot Diagnostics - UKR Trawl survey West, age 5
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

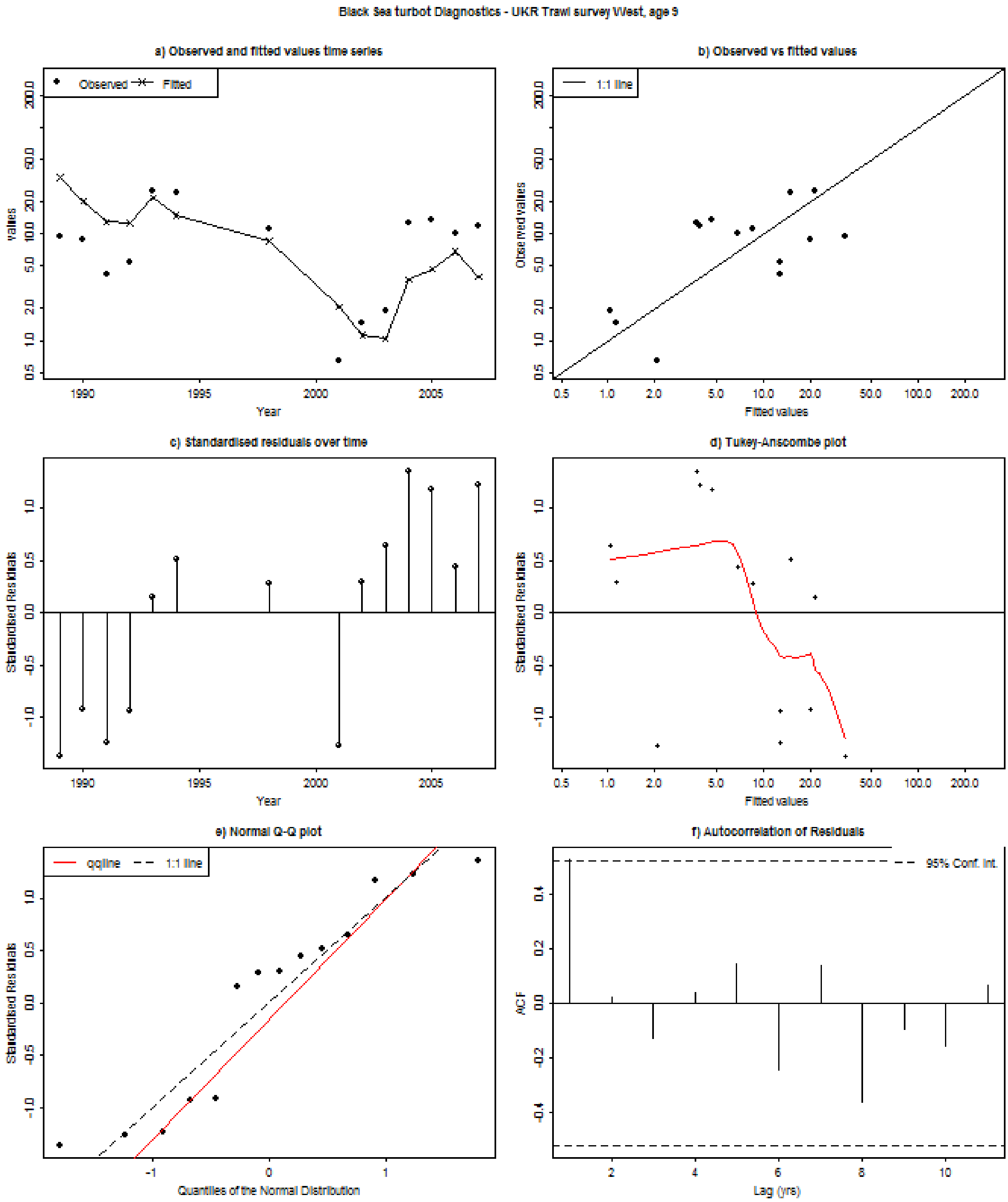
Black Sea turbot Diagnostics - UKR Trawl survey West, age 6



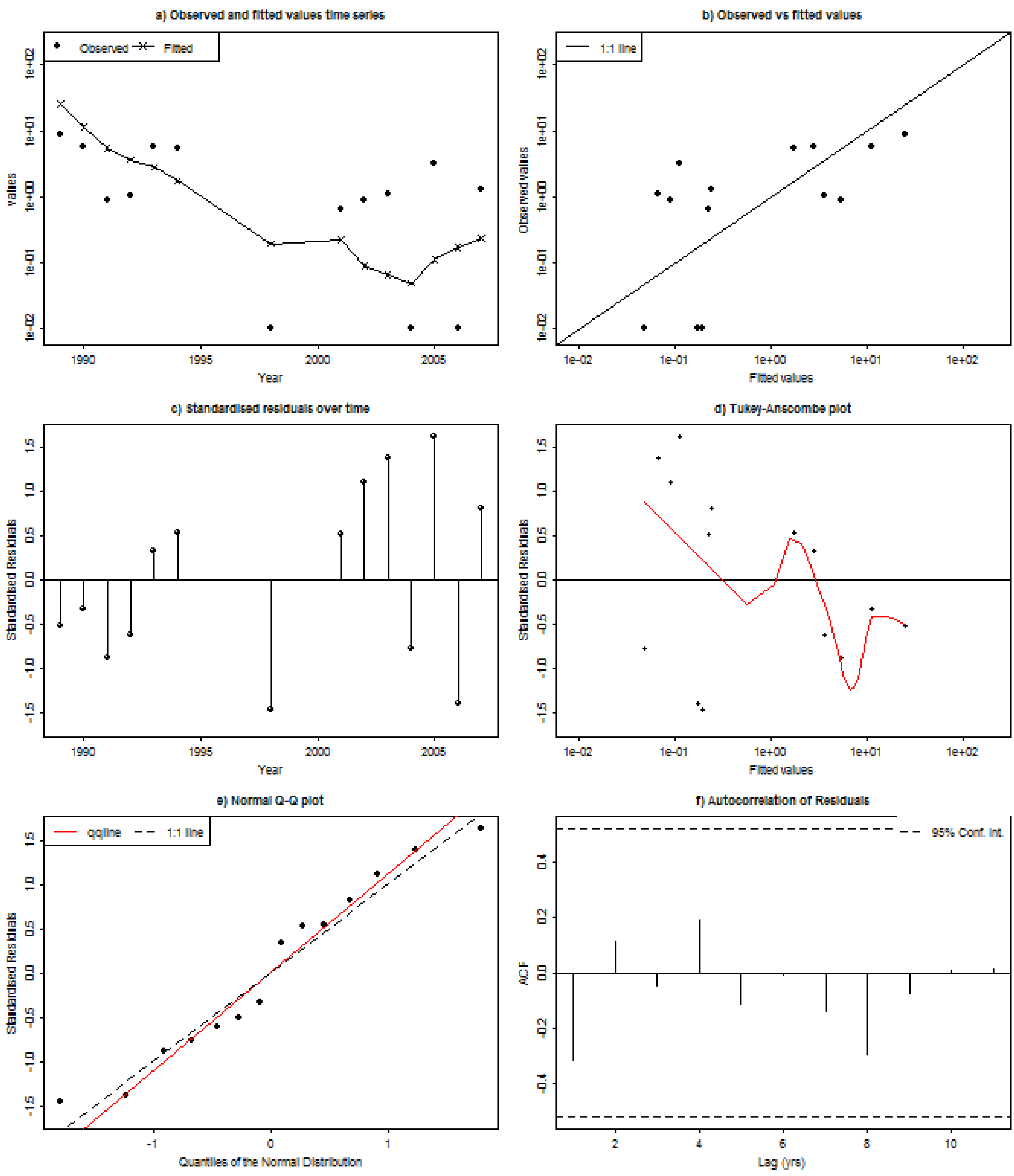

Black Sea turbot Diagnostics - UKR Trawl survey West, age 7
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)



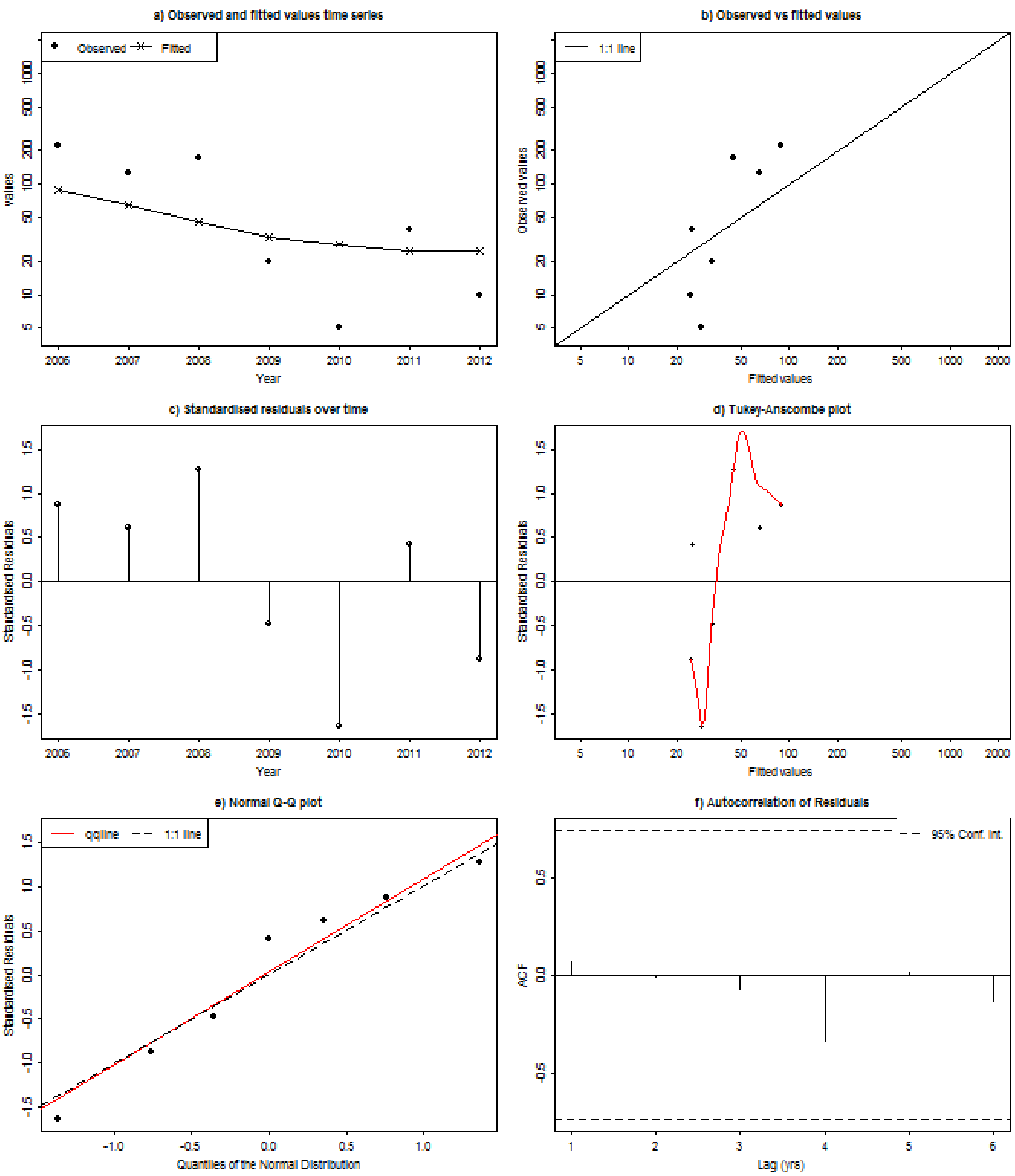
Black Sea turbot Diagnostics - UKR Trawl survey West, age 8
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)


Black Sea turbot Diagnostics - UKR Trawl survey West, age 9
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

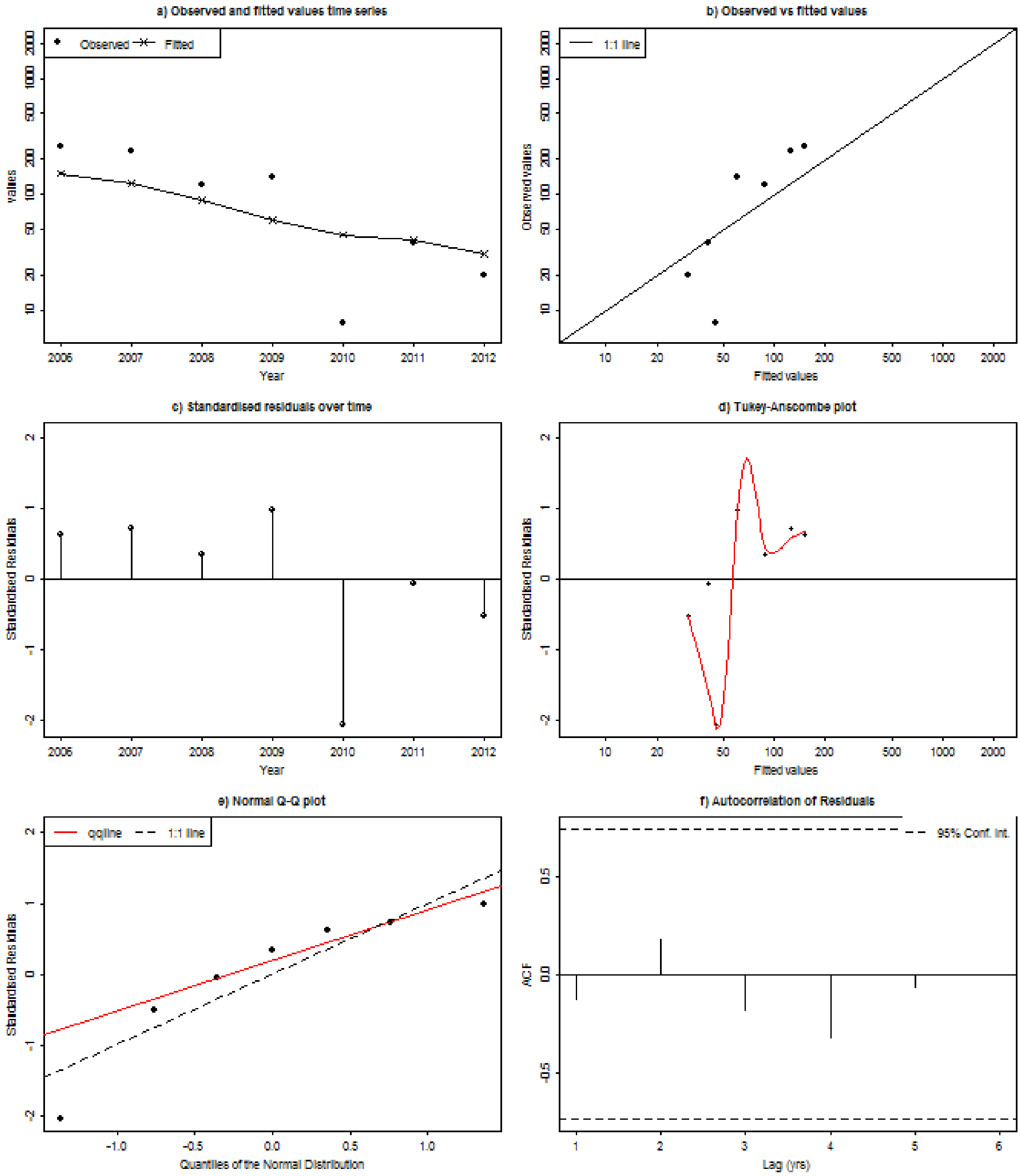
Black Sea turbot Diagnostics - UKR Trawl survey West, age 10

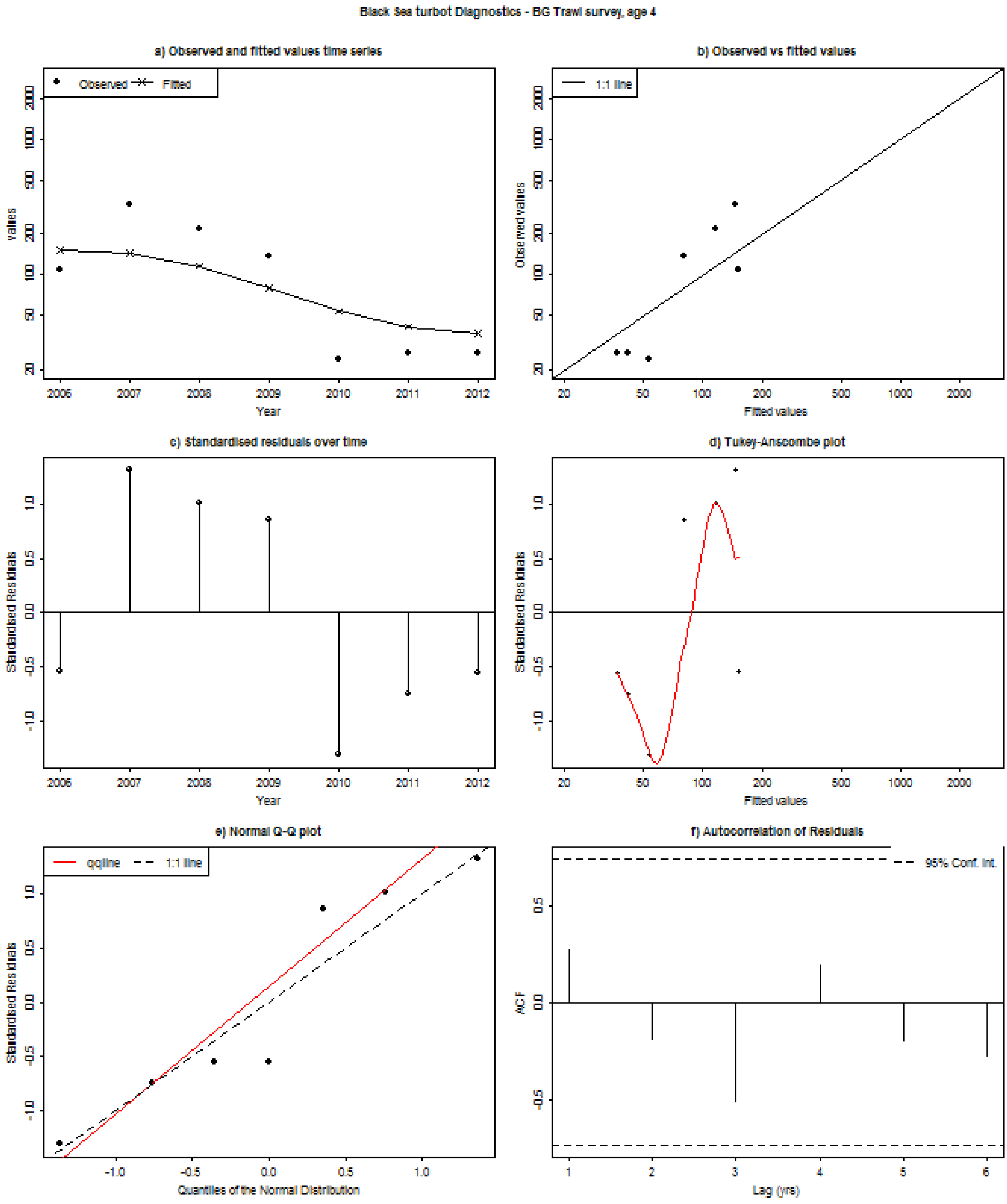


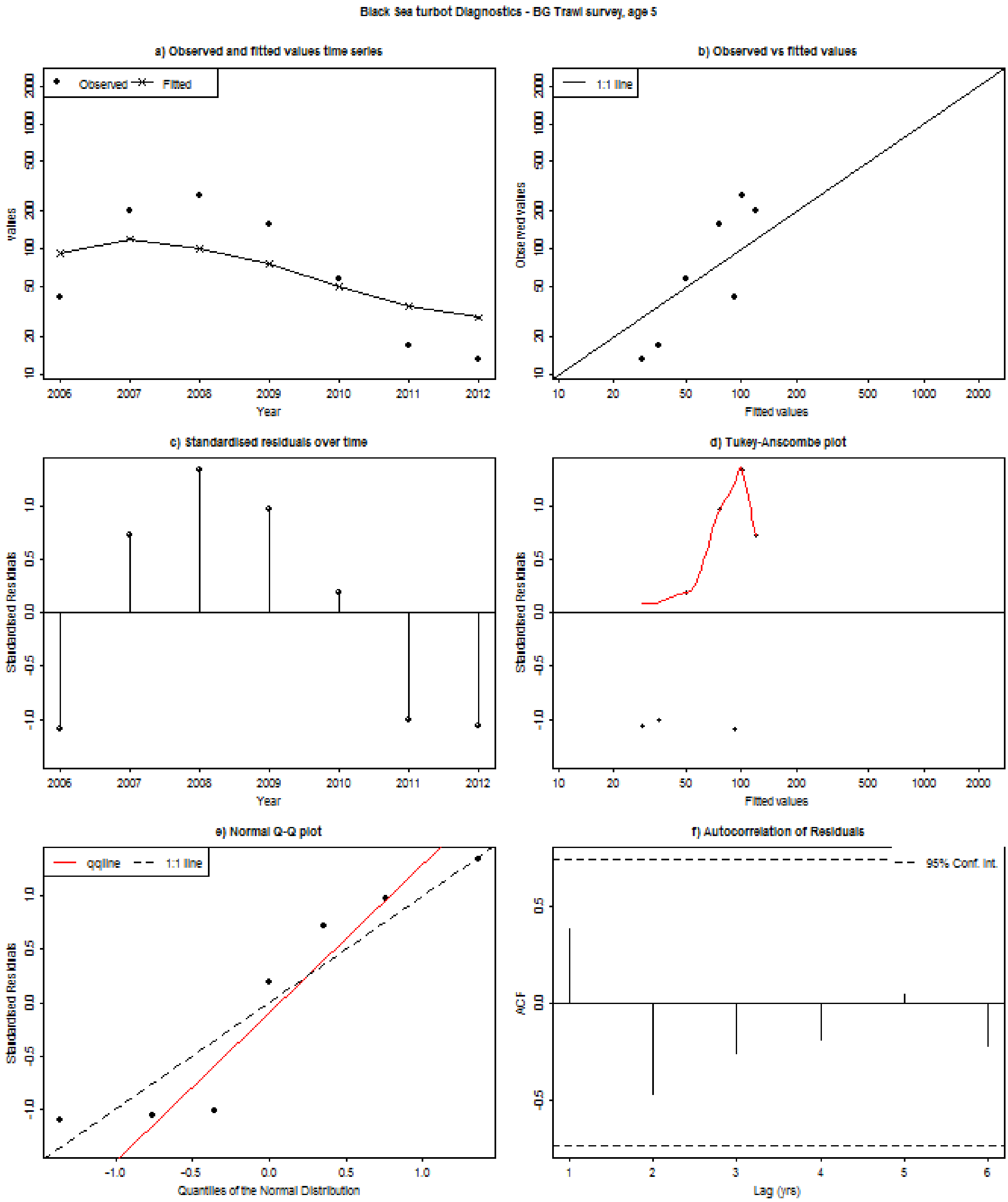
Black Sea turbot Diagnostics - BG Trawl survey, age 2



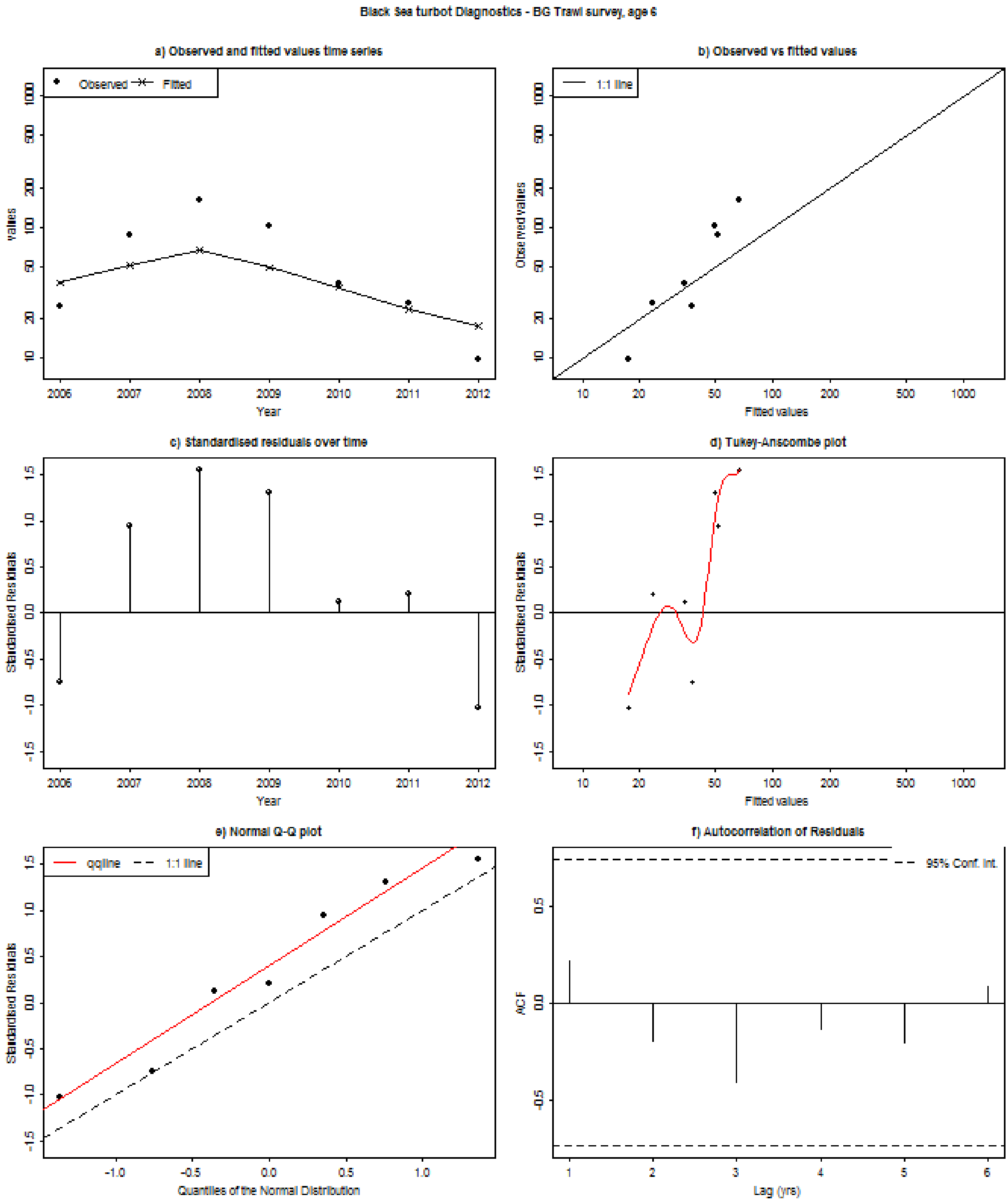
Black Sea turbot Diagnostics - BG Trawl survey, age 3



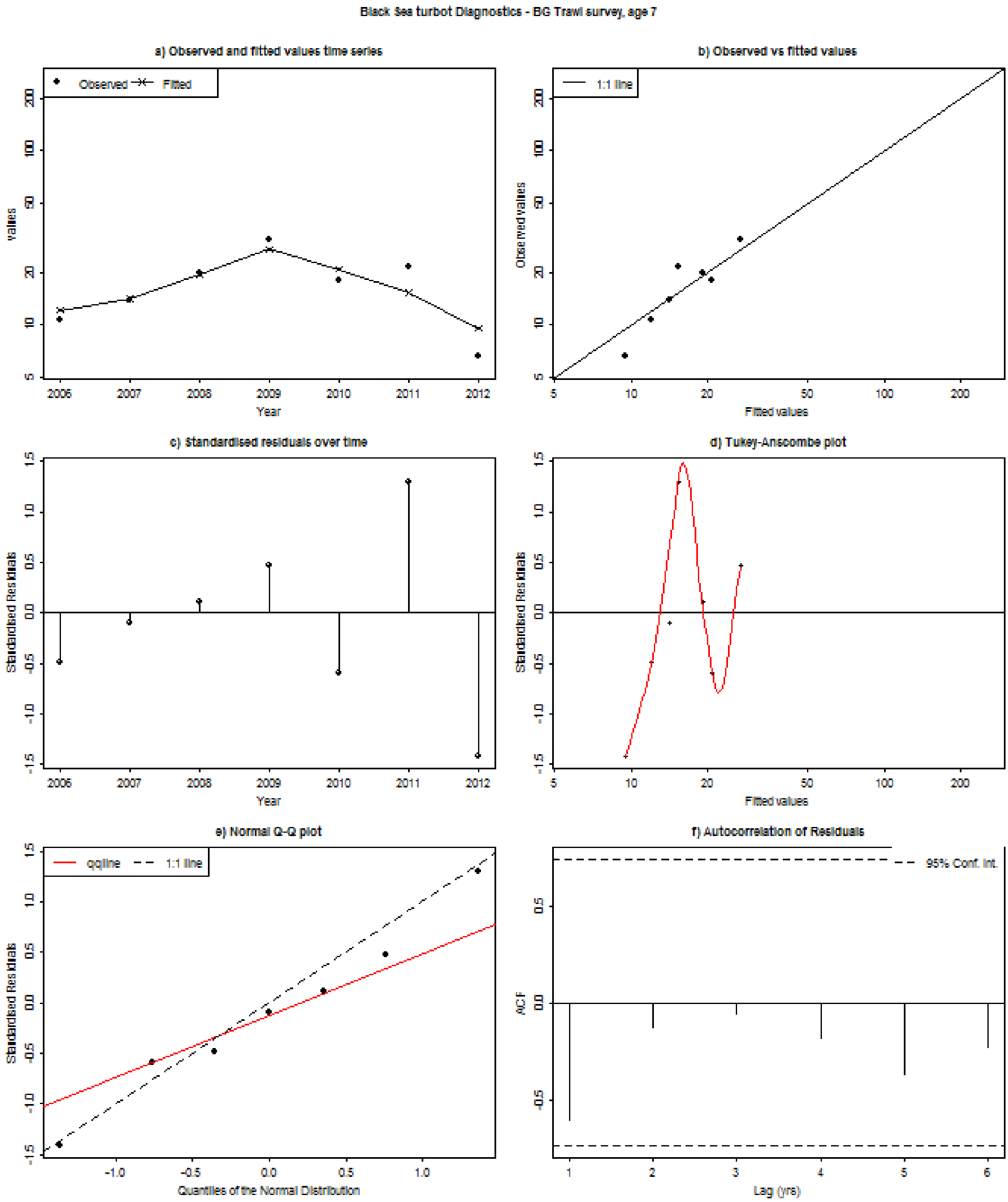

Black Sea turbot Diagnostics - BG Trawl survey, age 4
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)



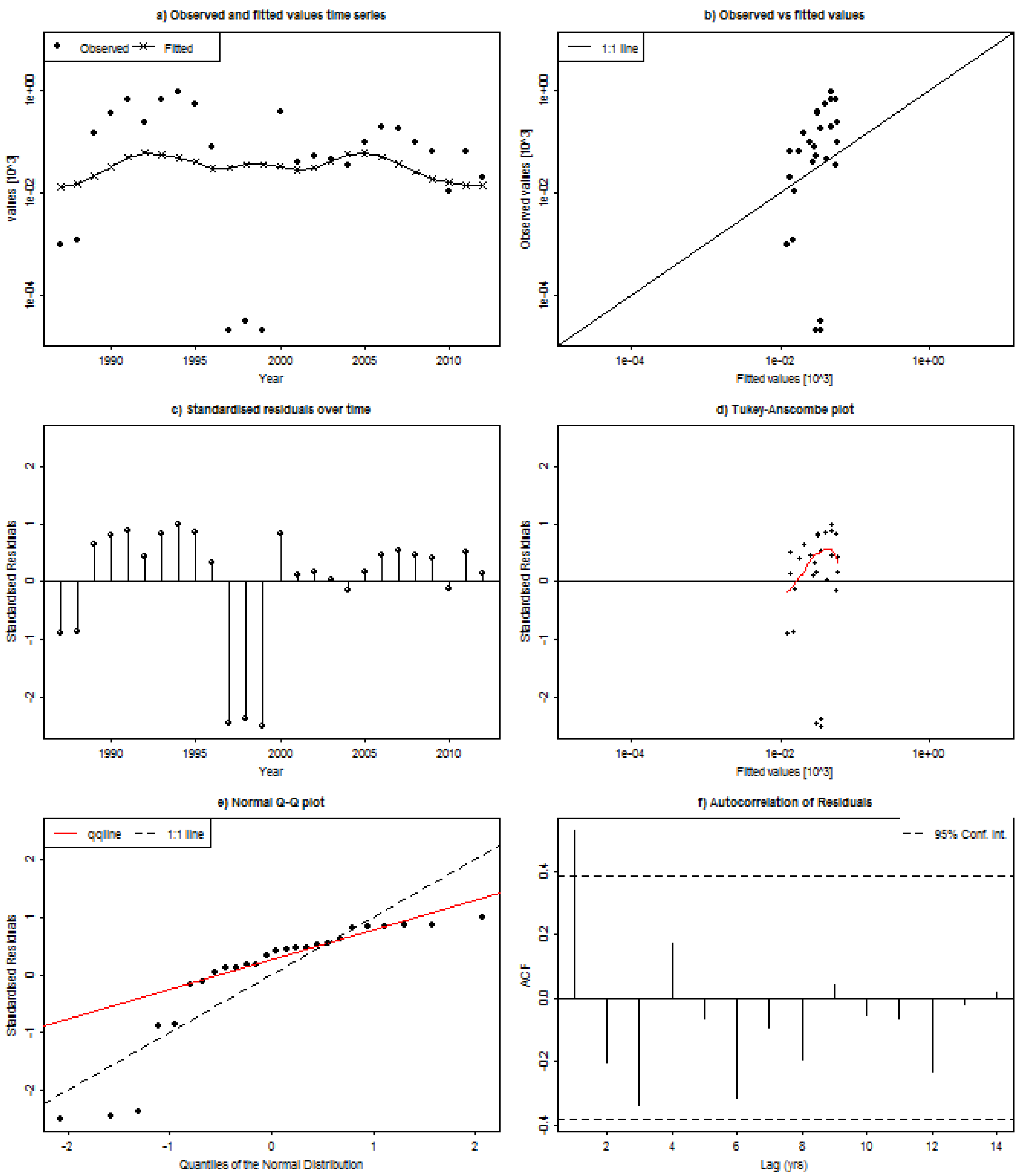
Black Sea turbot Diagnostics - BG Trawl survey, age 5
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

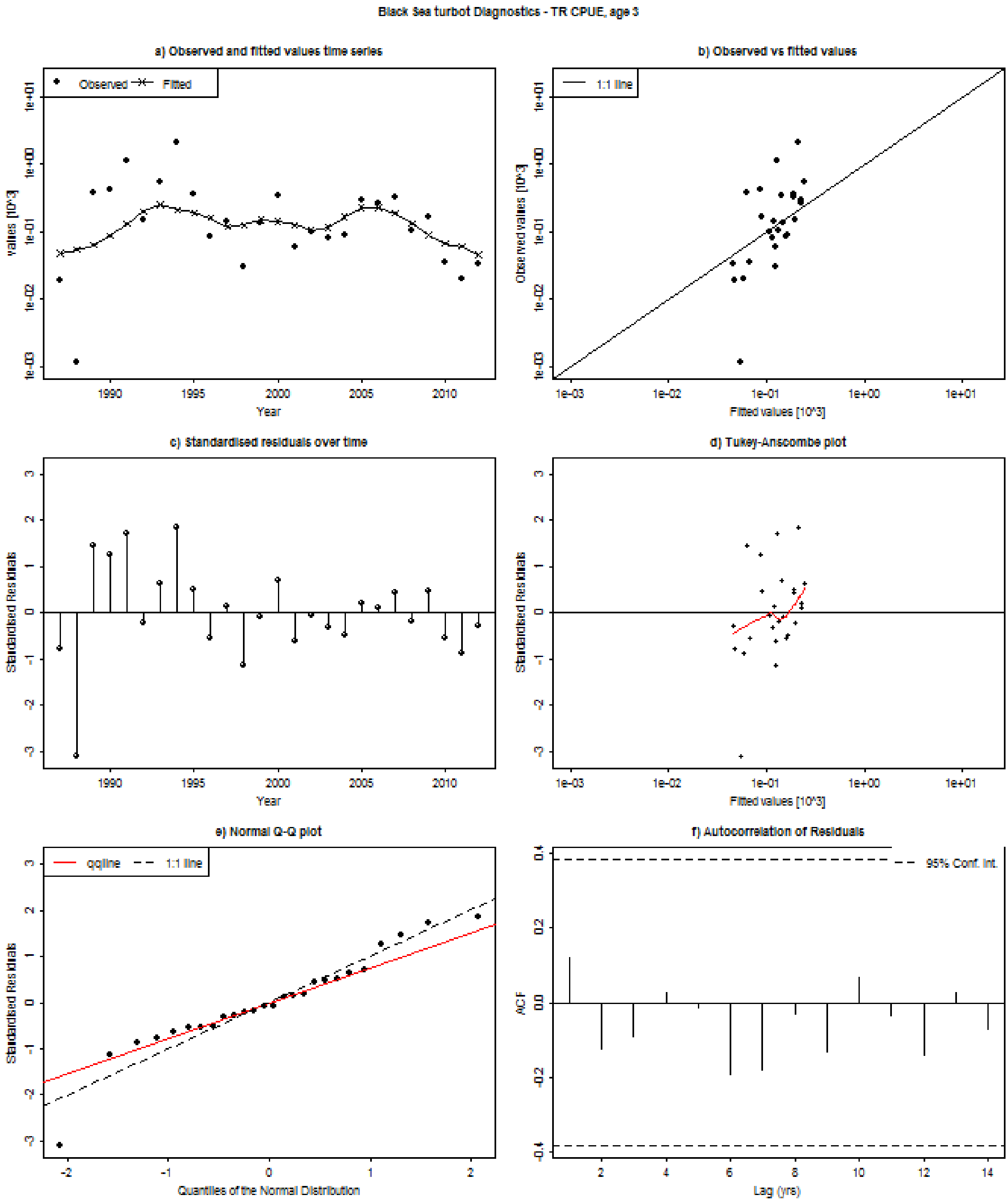


Black Sea turbot Diagnostics - BG Trawl survey, age 6
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)


Black Sea turbot Diagnostics - BG Trawl survey, age 7
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

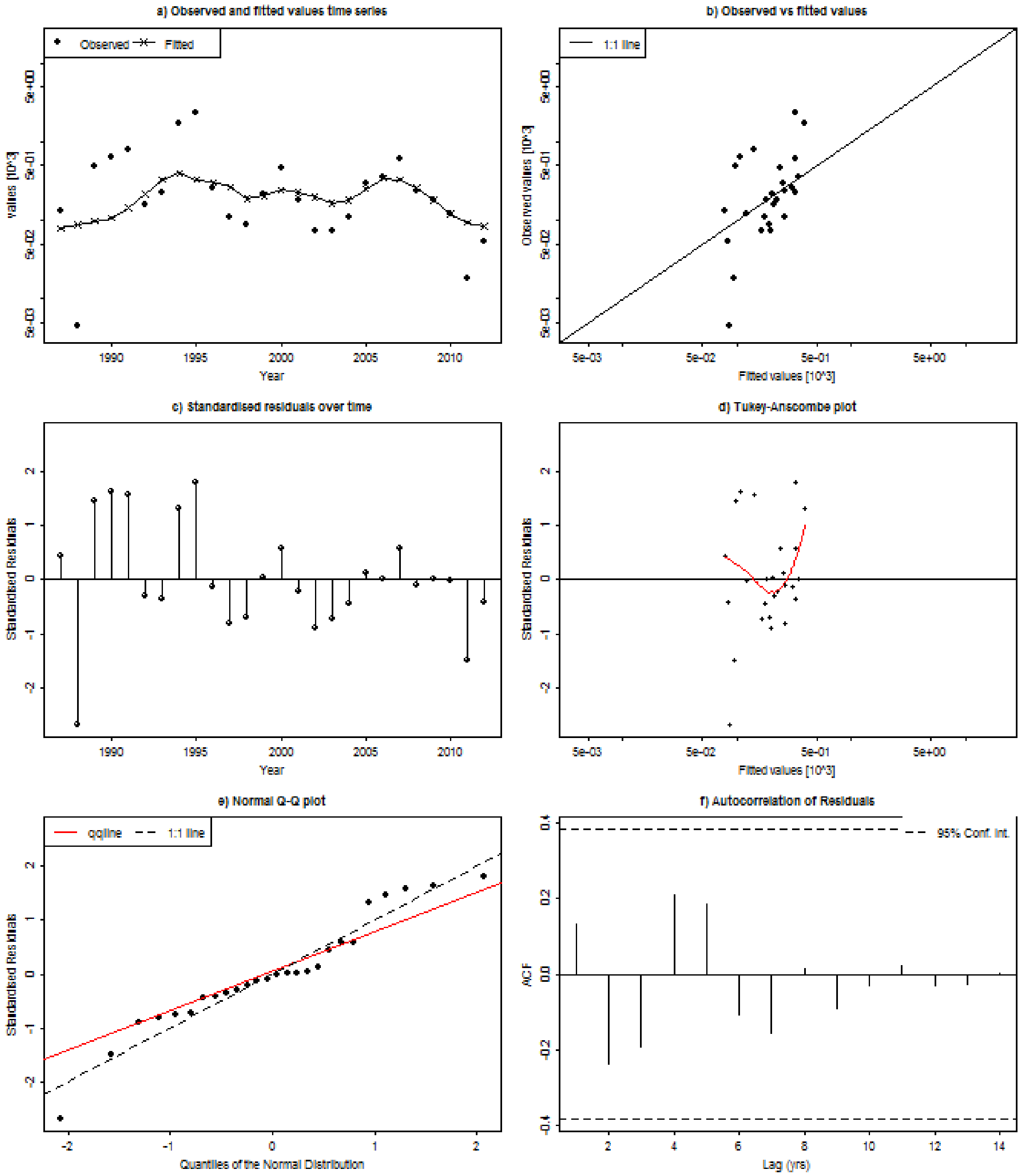
Black Sea turbot Diagnostics - TR CPUE, age 2



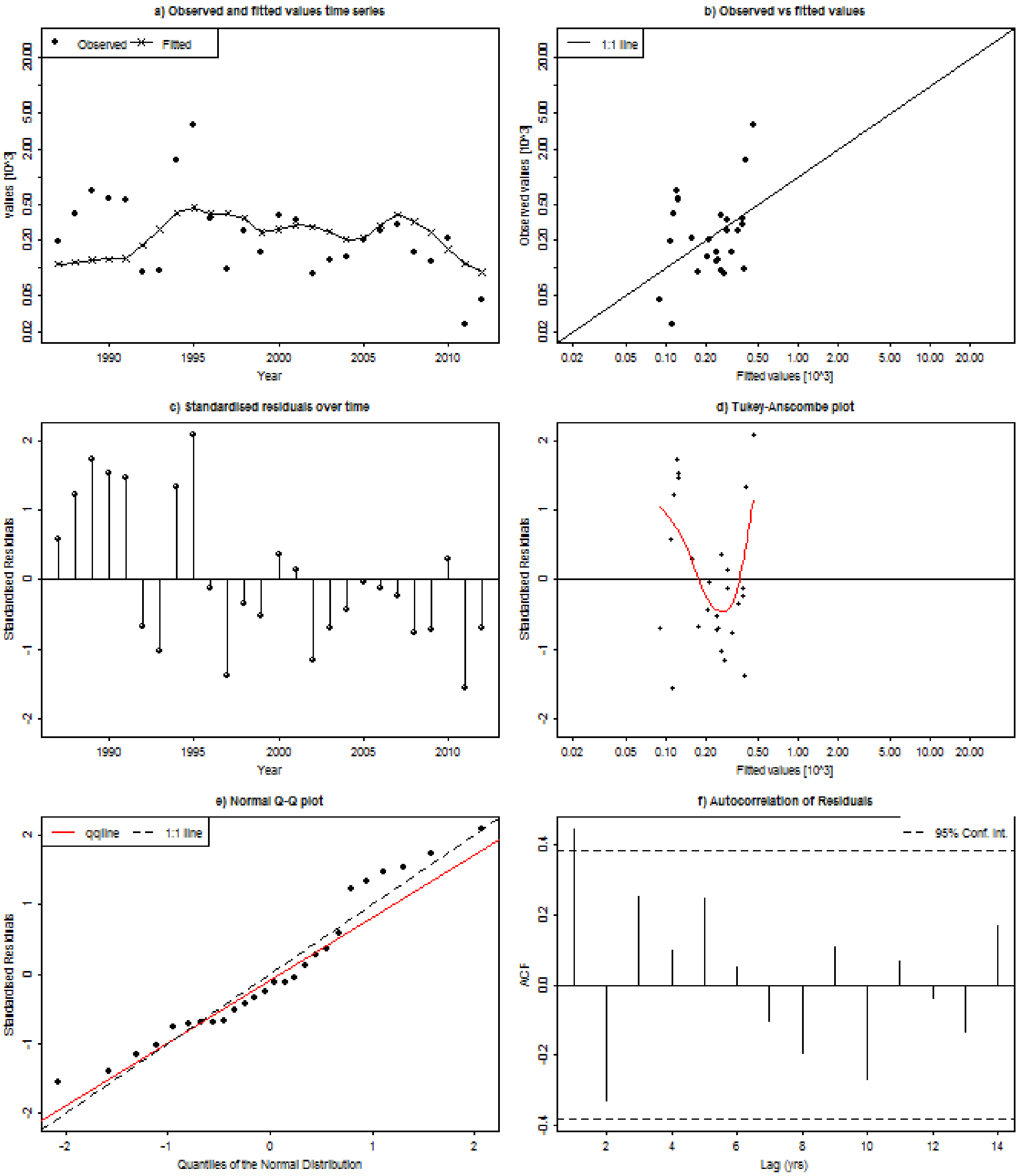


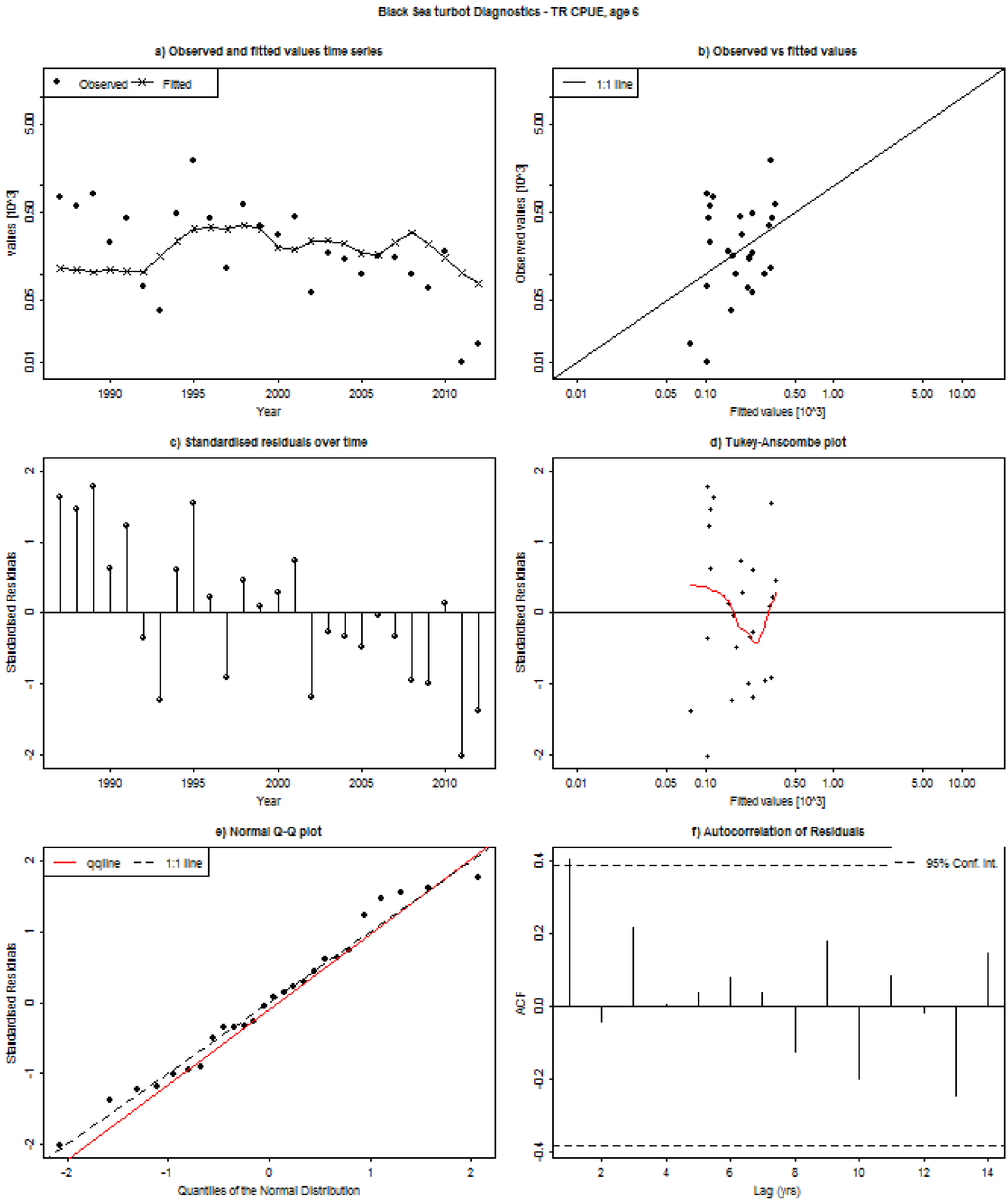
Black Sea turbot Diagnostics - TR CPUE, age 3
a) Observed and fitted values time series
Observed
Fitted
values [10^3]
Year
b) Observed vs fitted values
1:1 line
Observed values [10^3]
Fitted values [10^3]
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values [10^3]
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

Black Sea turbot Diagnostics - TR CPUE, age 4

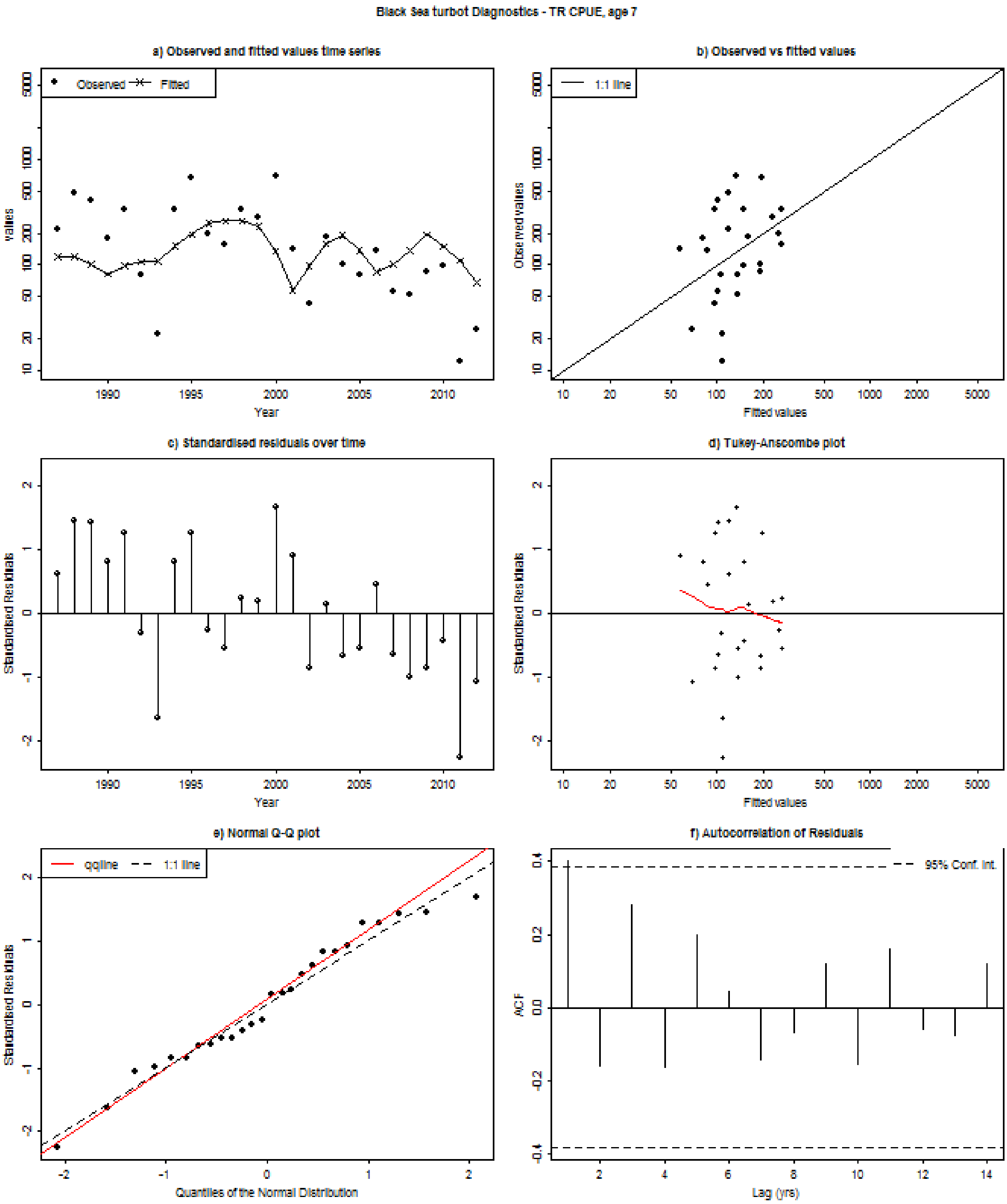


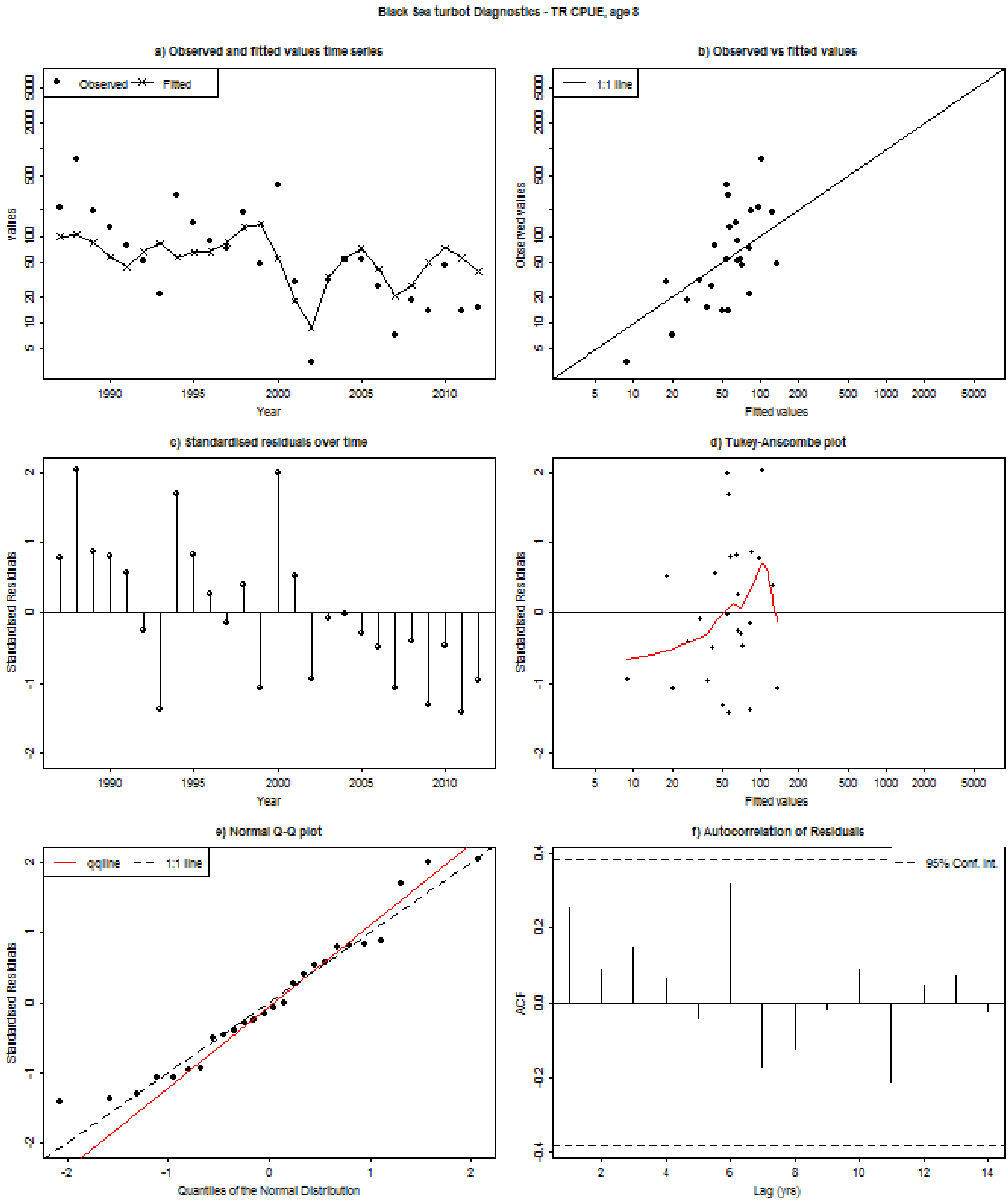
Black Sea turbot Diagnostics - TR CPUE, age 5





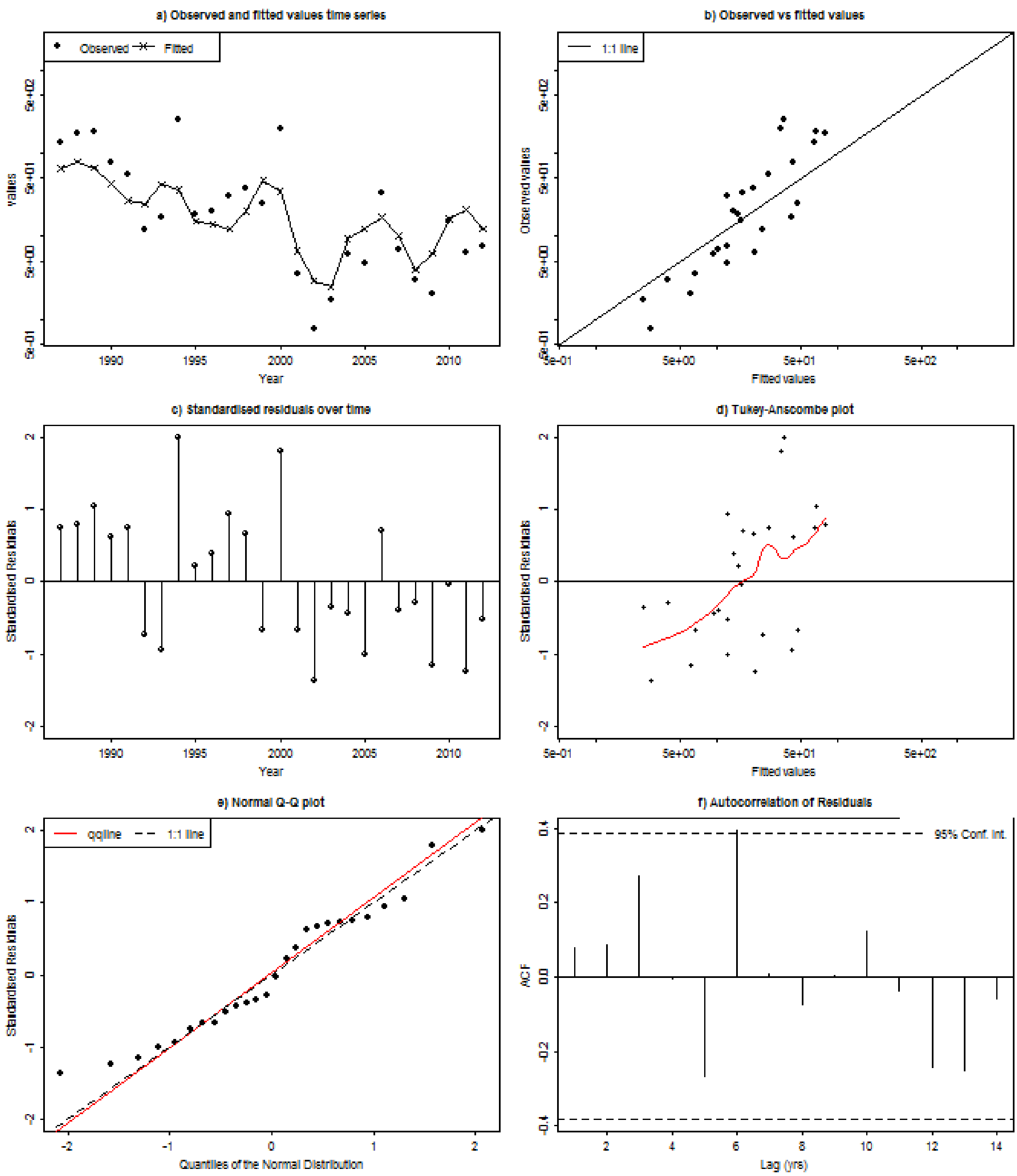
Black Sea turbot Diagnostics - TR CPUE, age 6
a) Observed and fitted values time series
Observed
Fitted
values [10^3]
Year
b) Observed vs fitted values
1:1 line
Observed values [10^3]
Fitted values [10^3]
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values [10^3]
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

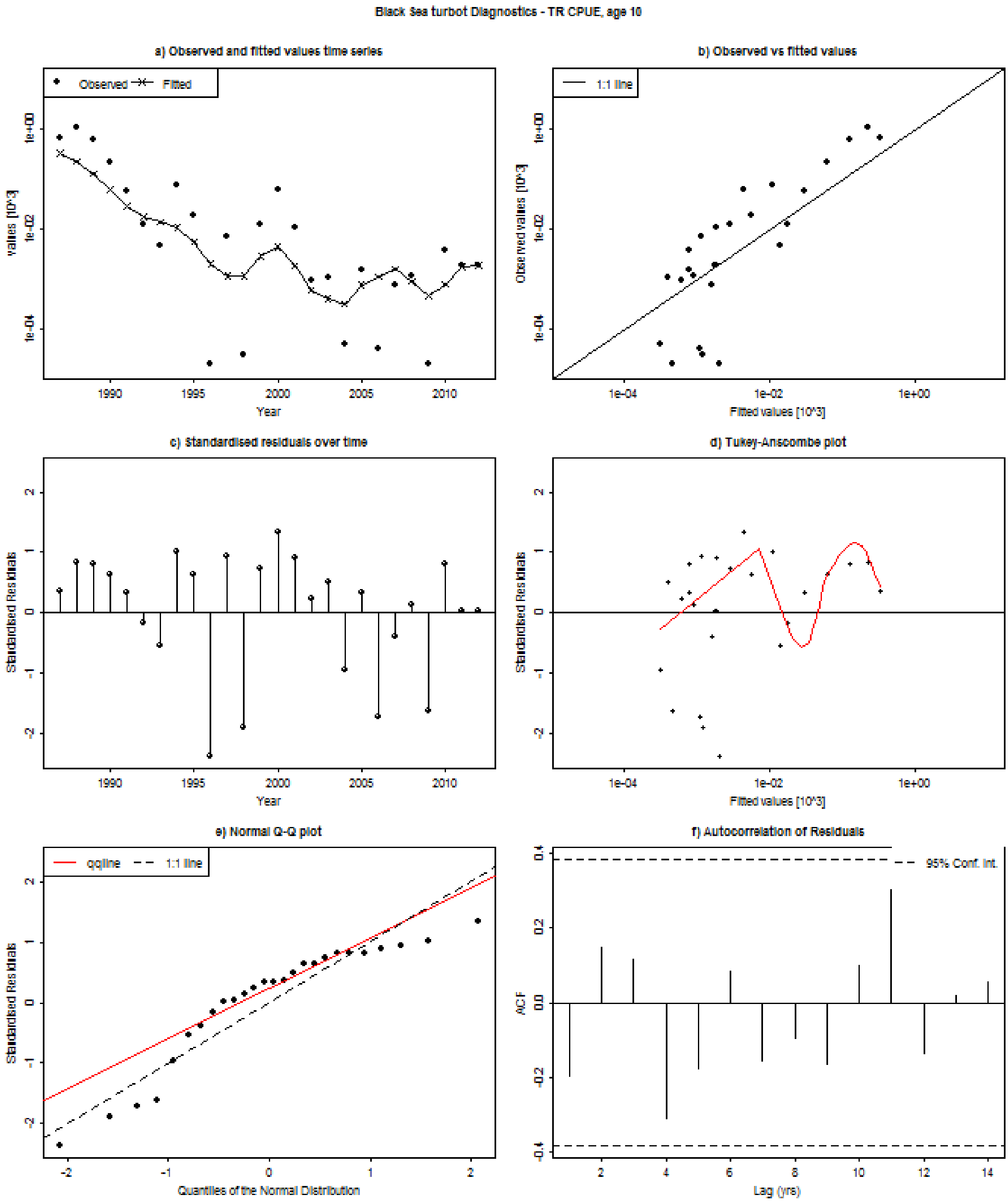

Black Sea turbot Diagnostics - TR CPUE, age 7
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

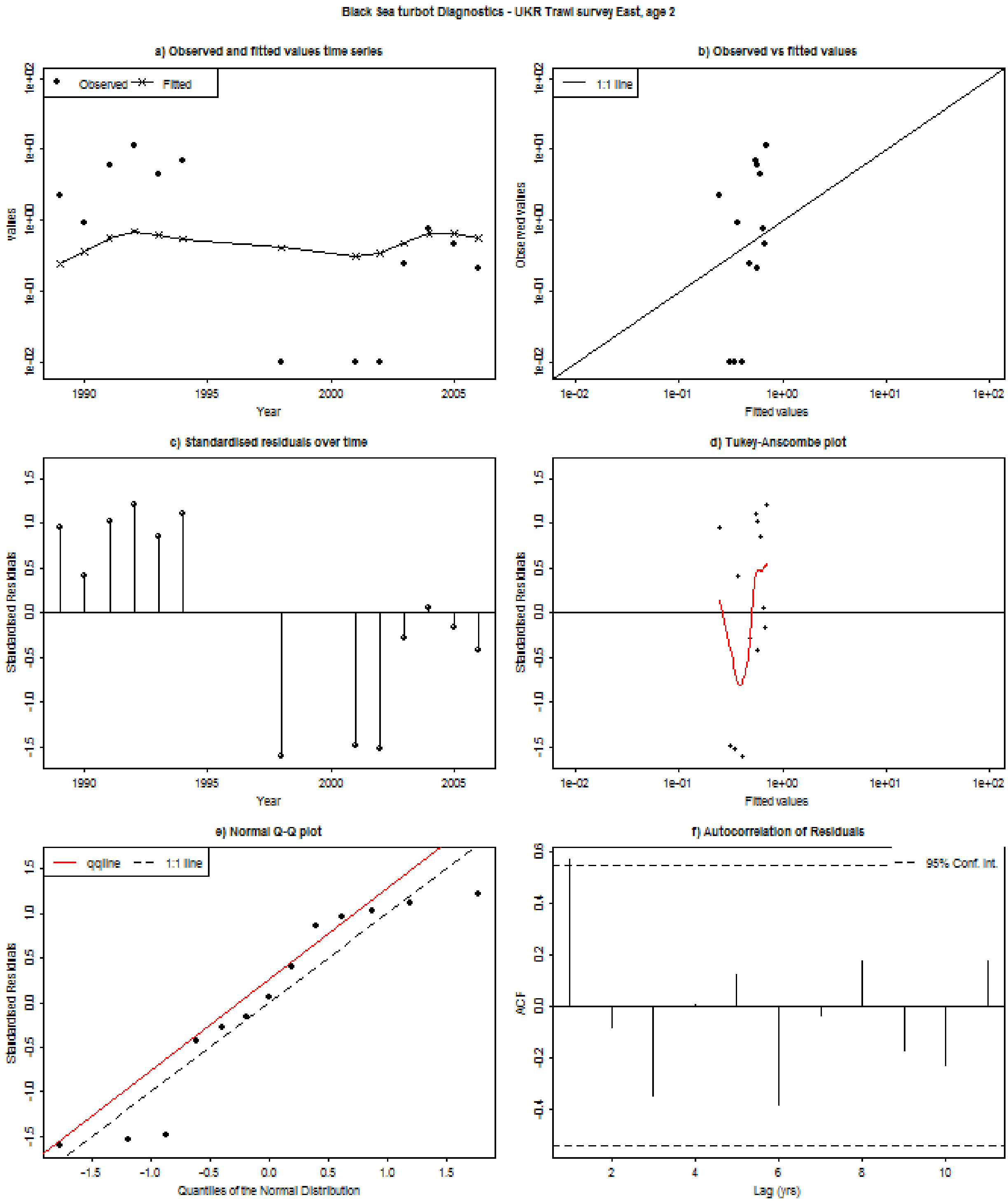


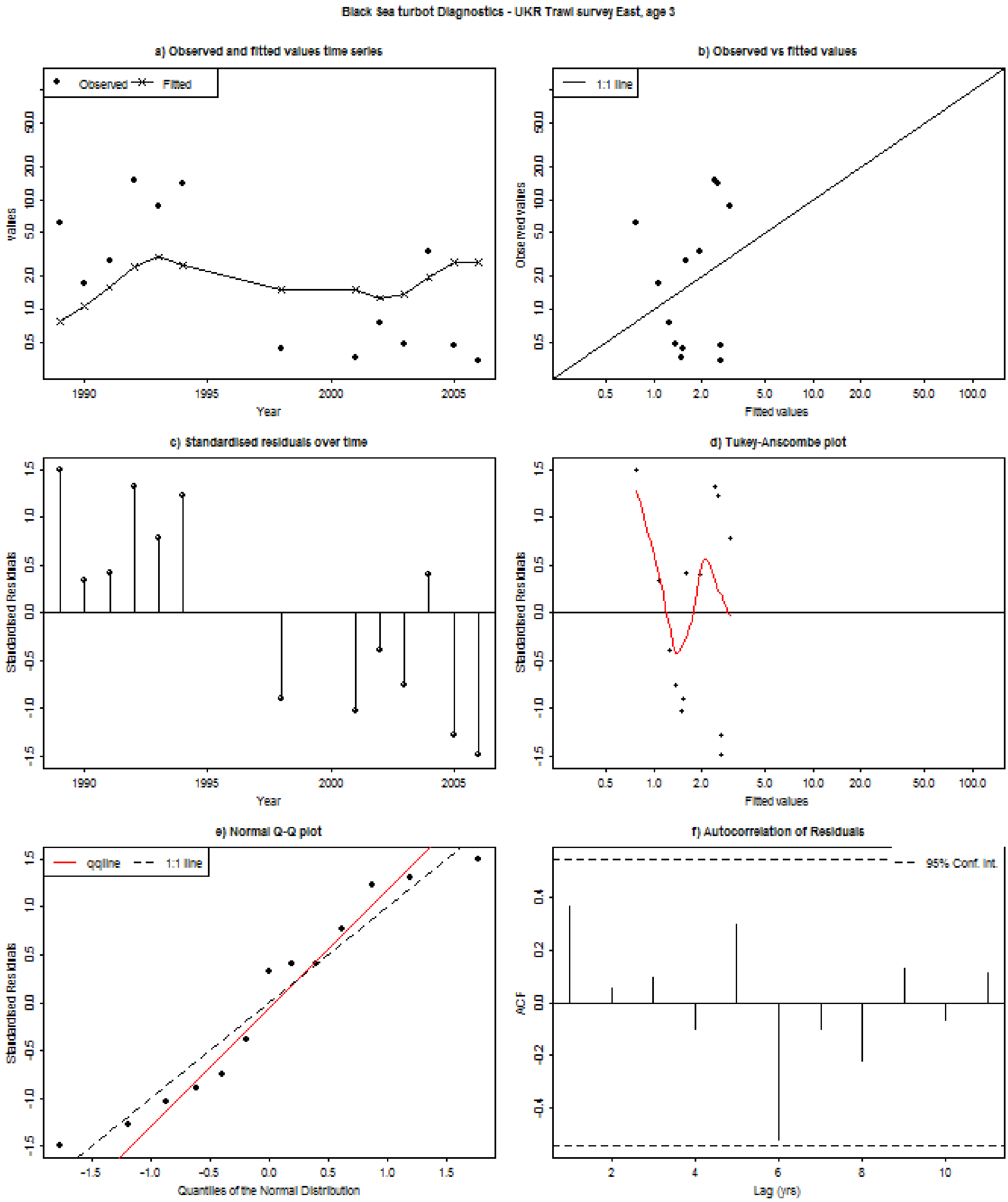
Black Sea turbot Diagnostics - TR CPUE, age 8
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

Black Sea turbot Diagnostics - TR CPUE, age 9

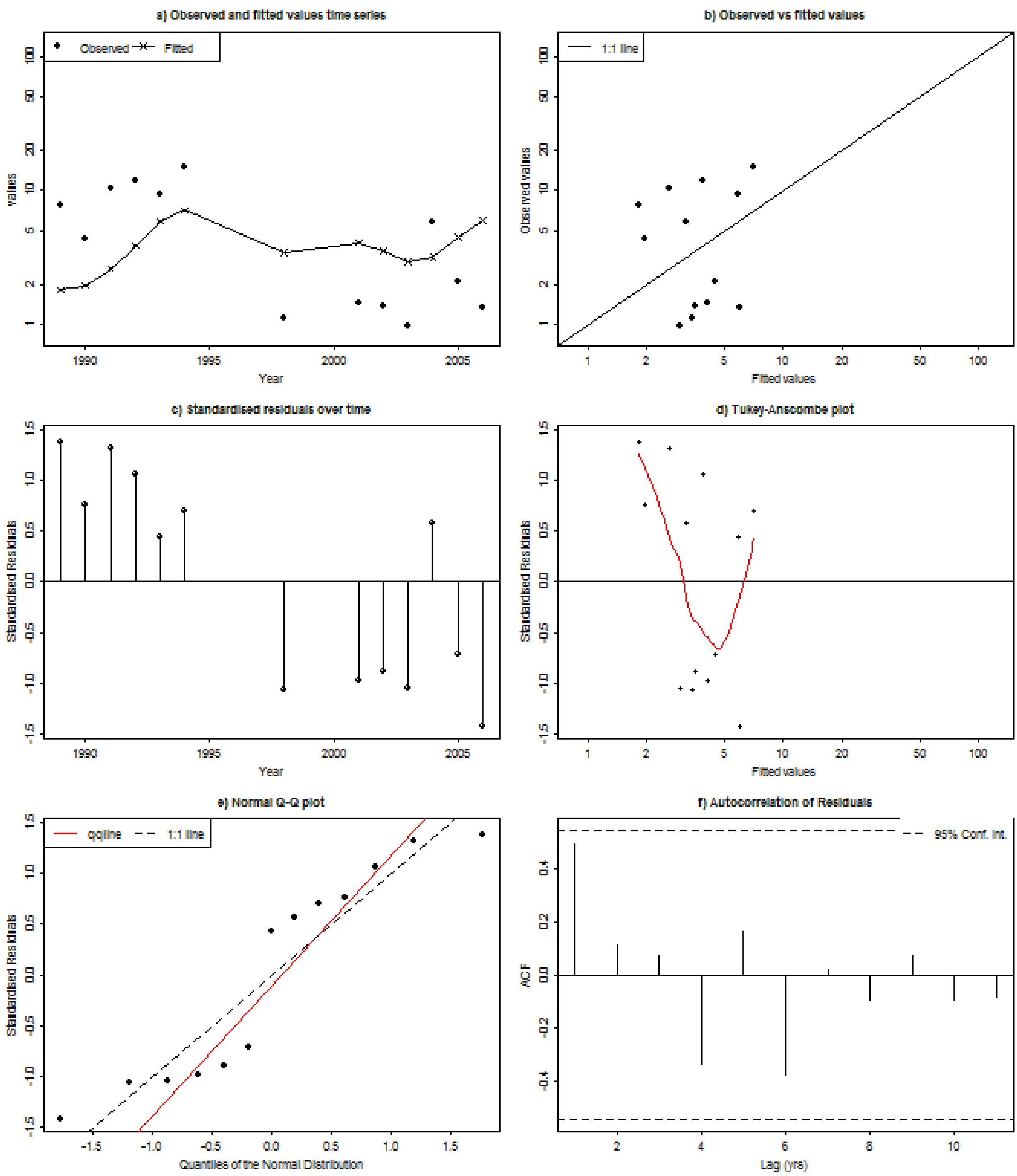



Black Sea turbot Diagnostics - TR CPUE, age 10
a) Observed and fitted values time series
Observed
Fitted
values [10^3]
Year
b) Observed vs fitted values
1:1 line
Observed values [10^3]
Fitted values [10^3]
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values [10^3]
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

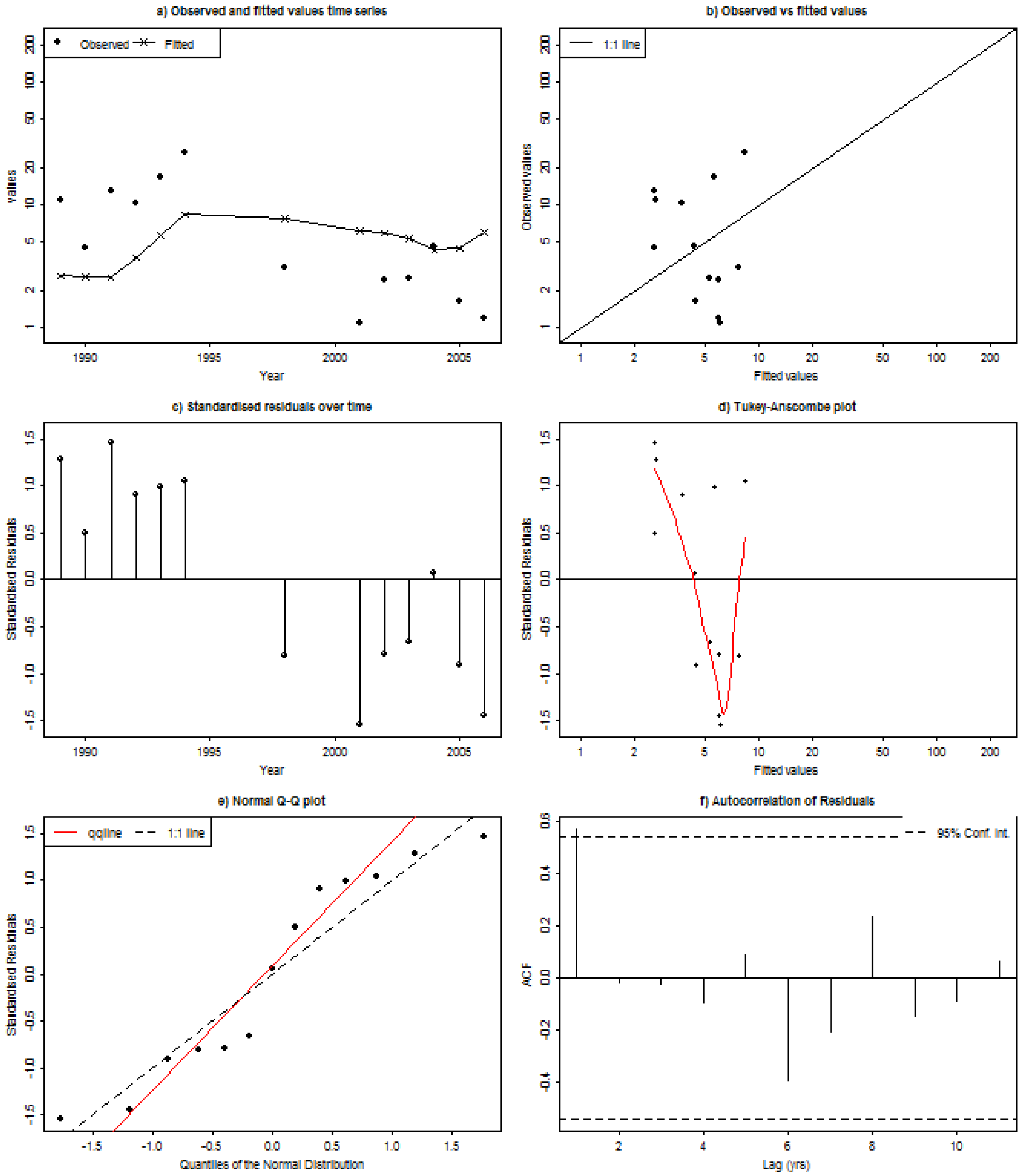

Black Sea turbot Diagnostics - UKR Trawl survey East, age 2
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

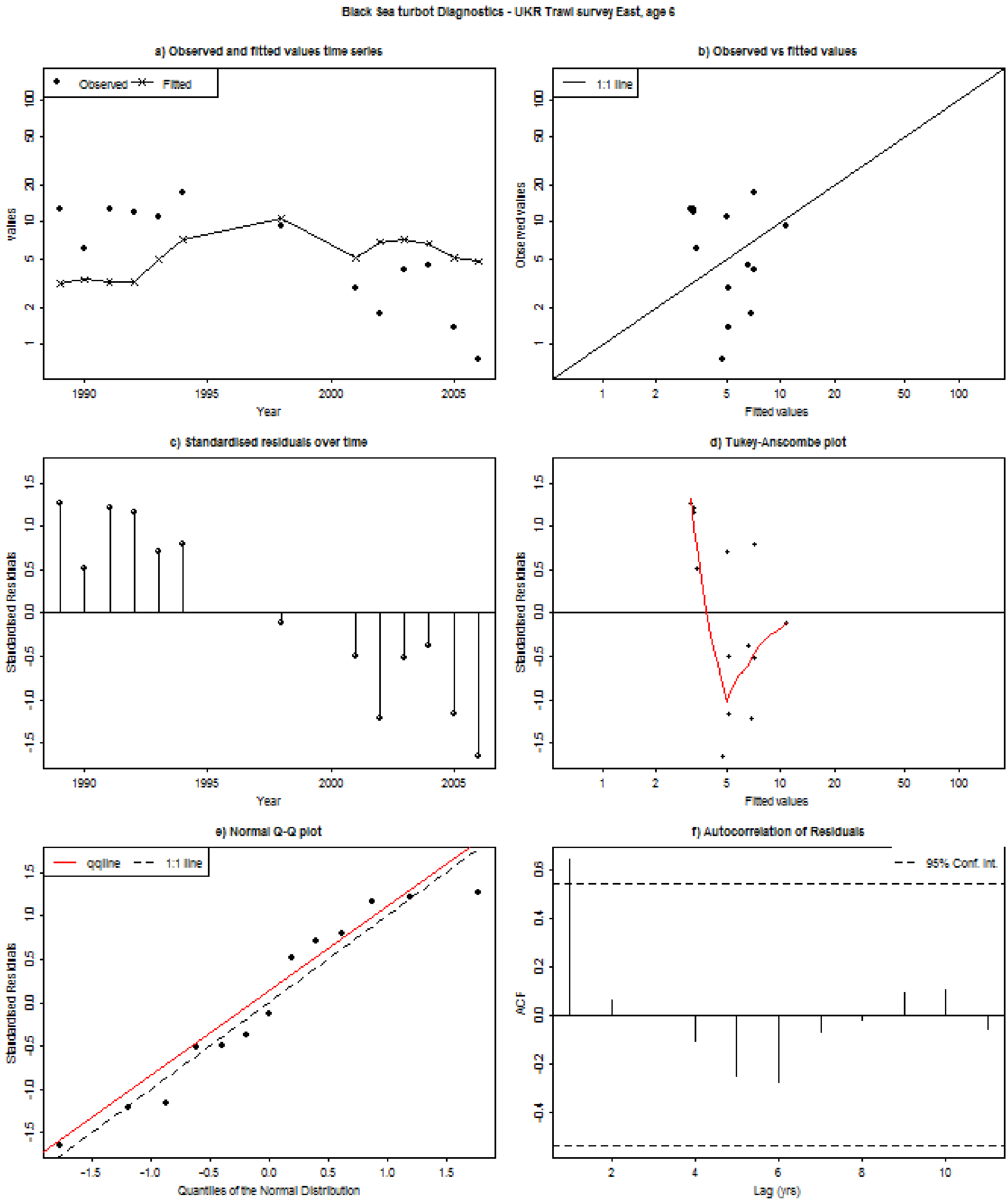

Black Sea turbot Diagnostics - UKR Trawl survey East, age 3
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

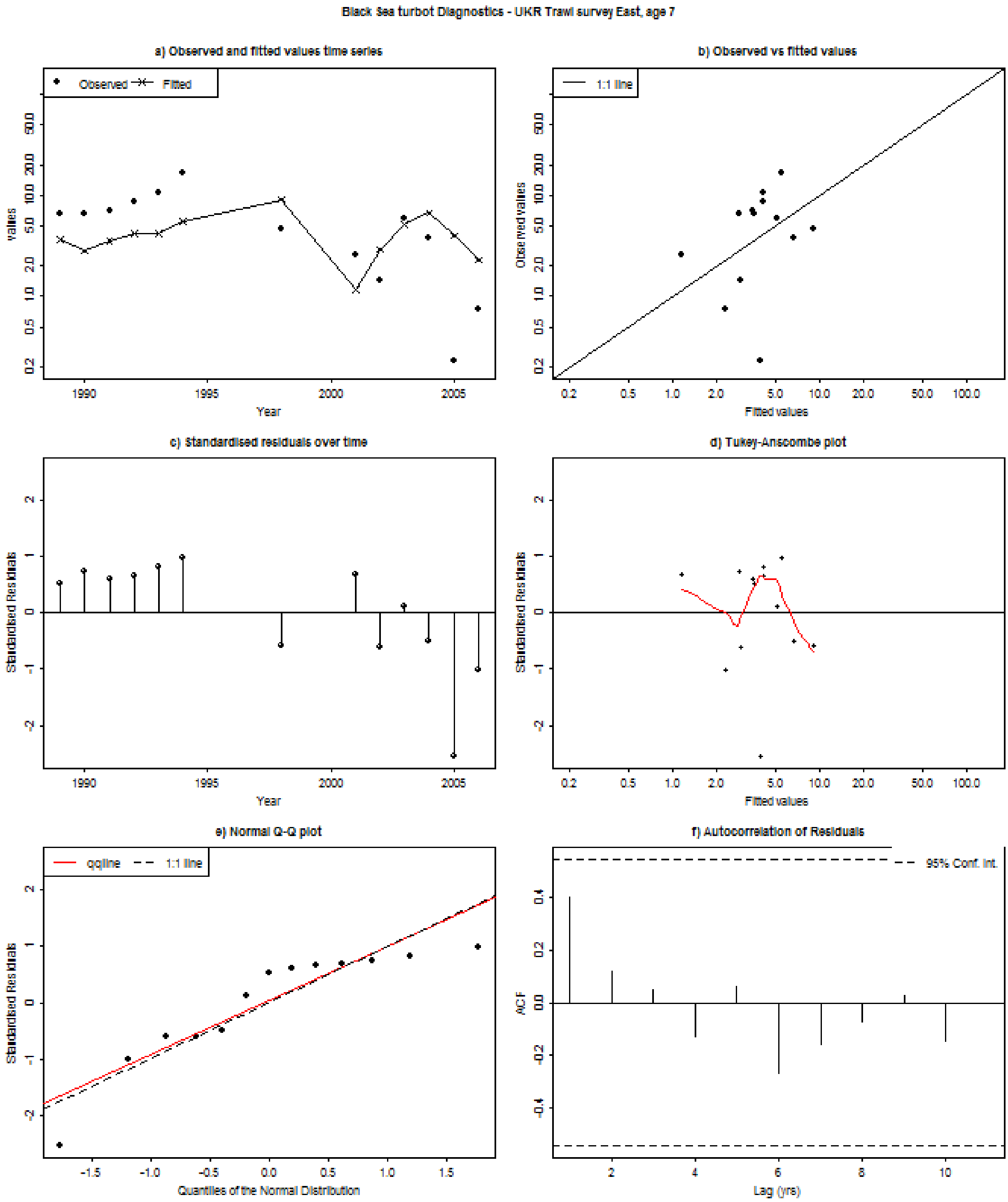
Black Sea turbot Diagnostics - UKR Trawl survey East, age 4



Black Sea turbot Diagnostics - UKR Trawl survey East, age 5

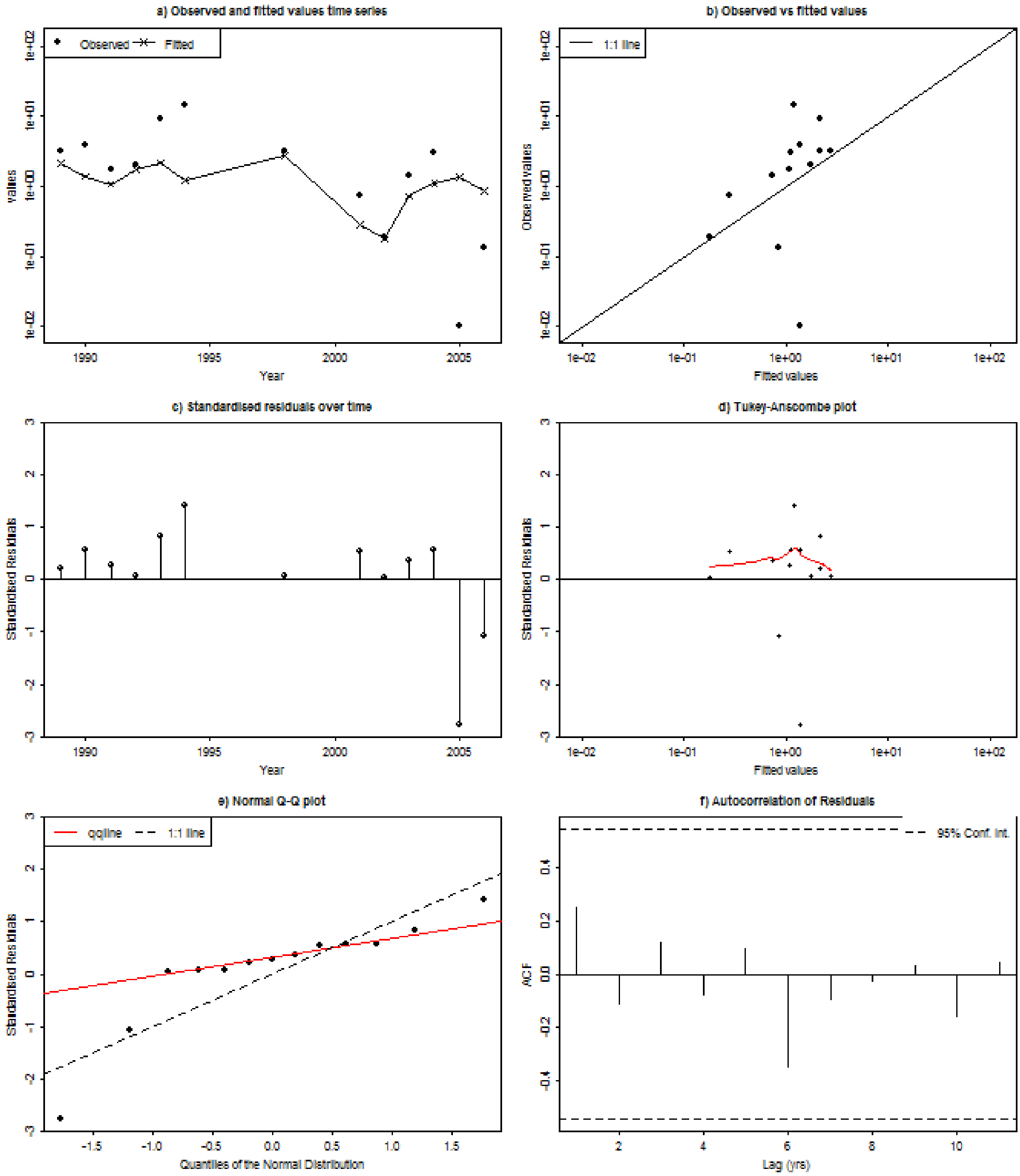



Black Sea turbot Diagnostics - UKR Trawl survey East, age 6
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

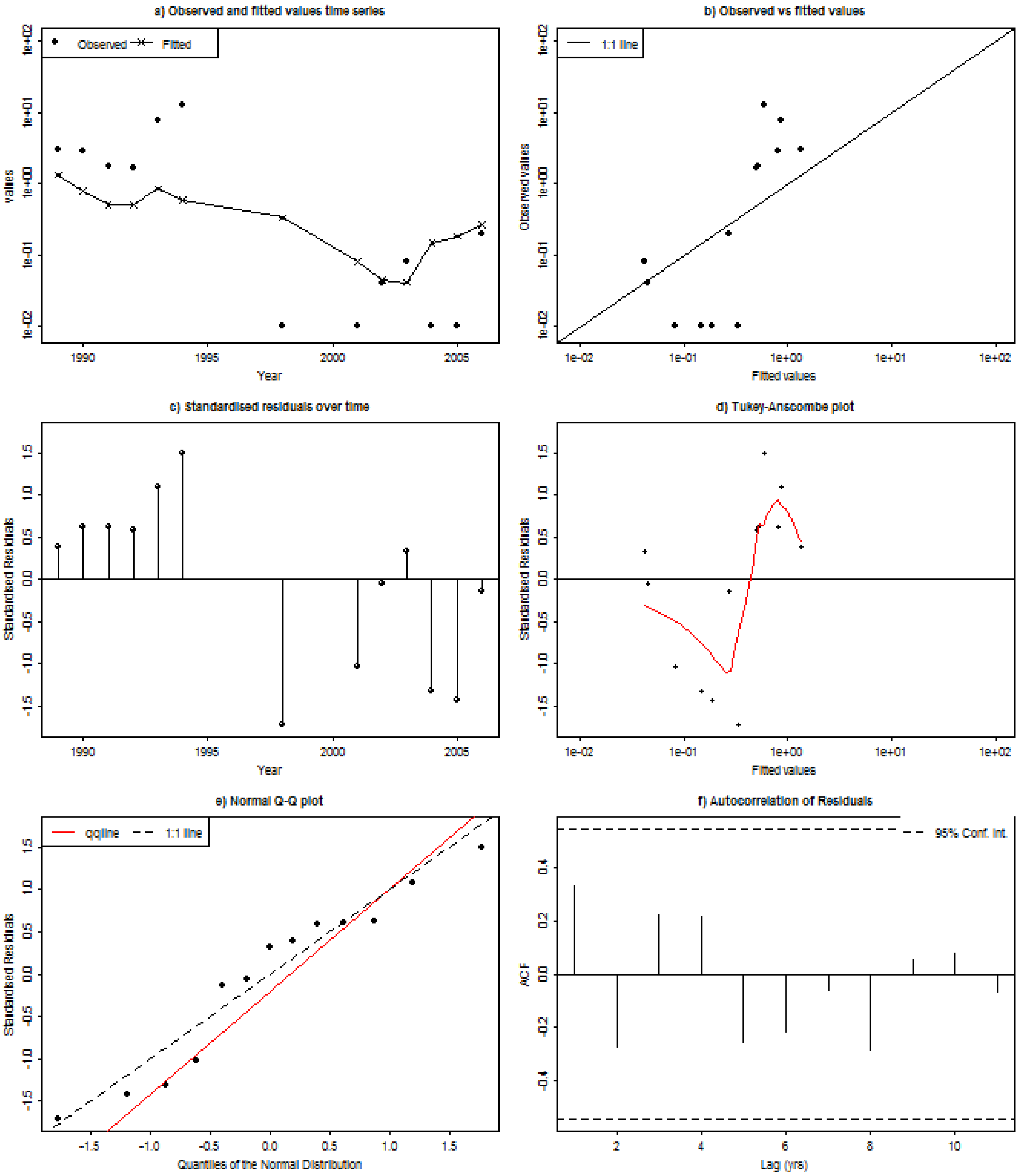


Black Sea turbot Diagnostics - UKR Trawl survey East, age 7
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

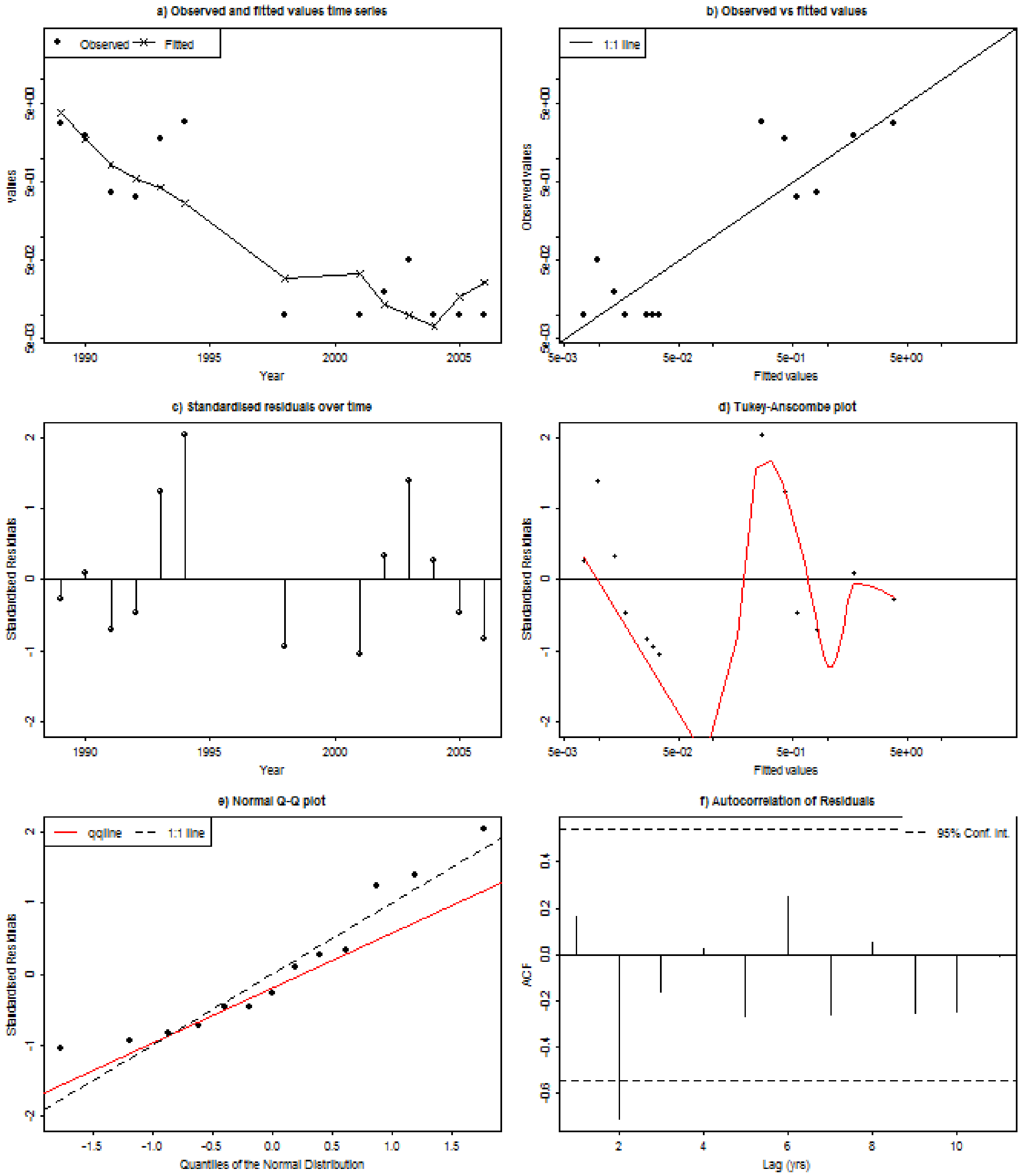
Black Sea turbot Diagnostics - UKR Trawl survey East, age 8



Black Sea turbot Diagnostics - UKR Trawl survey East, age 9



Black Sea turbot Diagnostics - UKR Trawl survey East, age 10



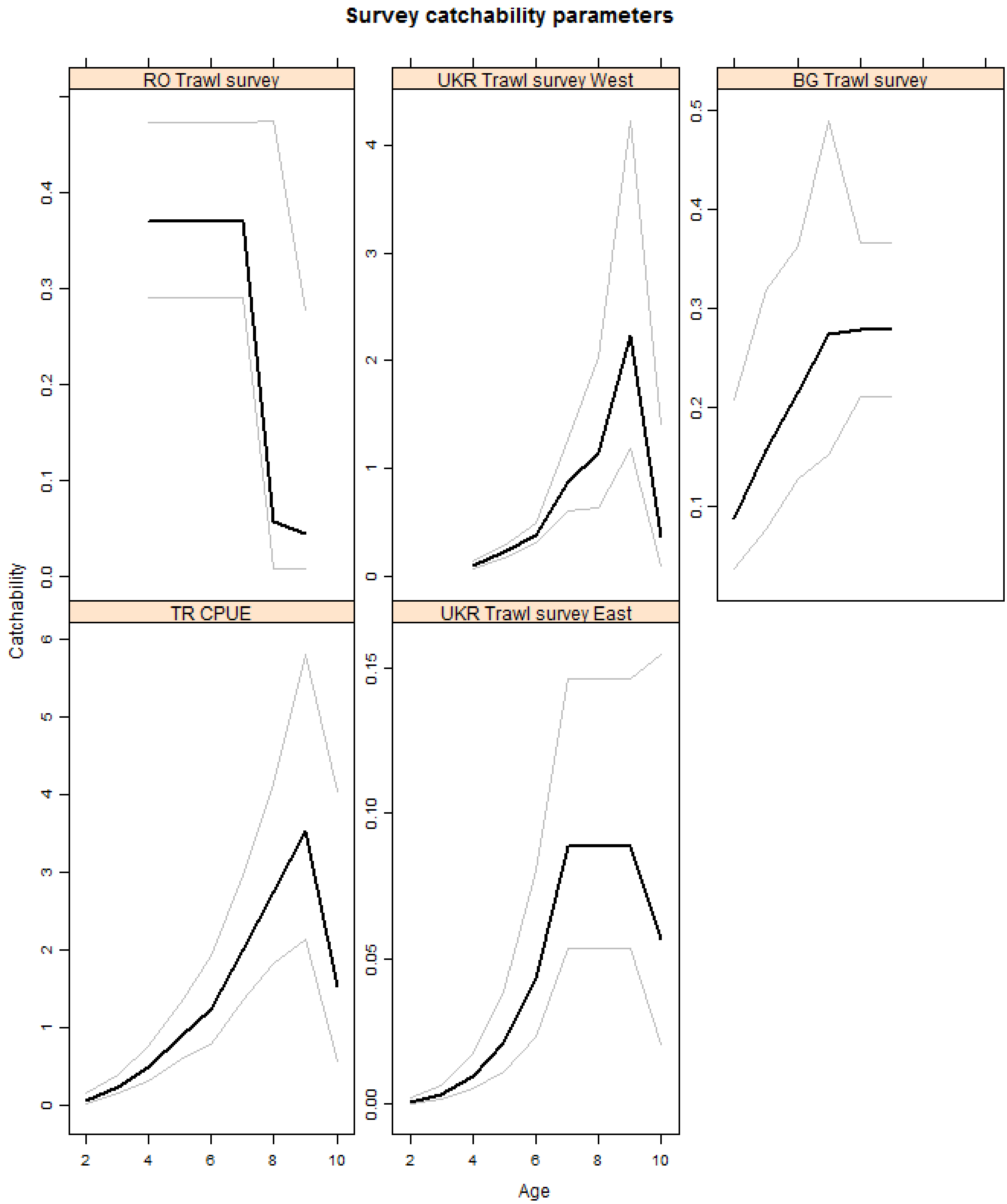


Figure 1.4.Black Sea turbot. Final run. Estimated survey catchabilities with 95% CI.

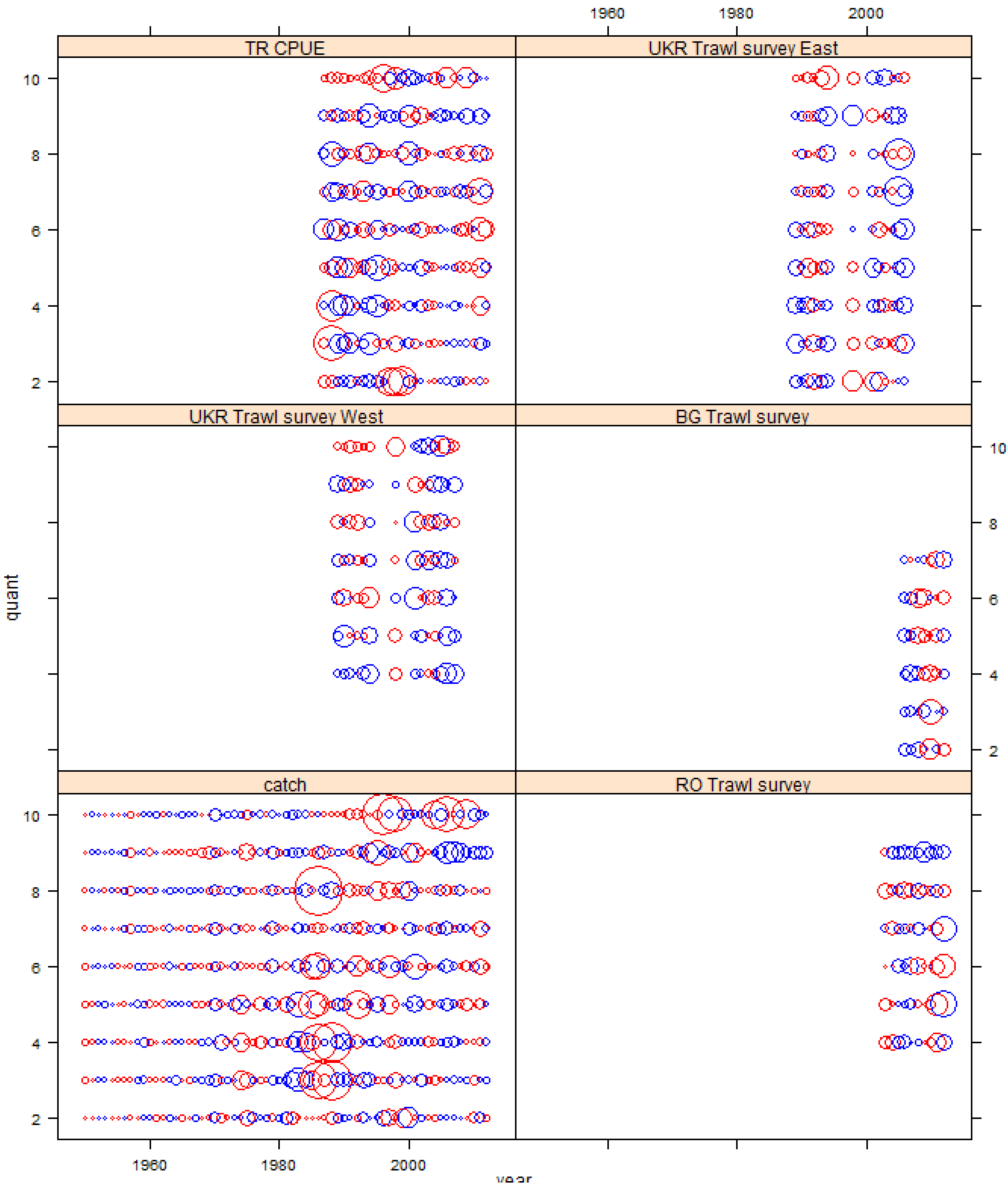


Figure 1.5.Black Sea turbot. Final run. Bubble plot showing the weighted residuals for each piece of fitted information. Individual values are weighted following the procedures employed internally with SAM in calculating the objective function. The bubble scale is consistent between all panels.

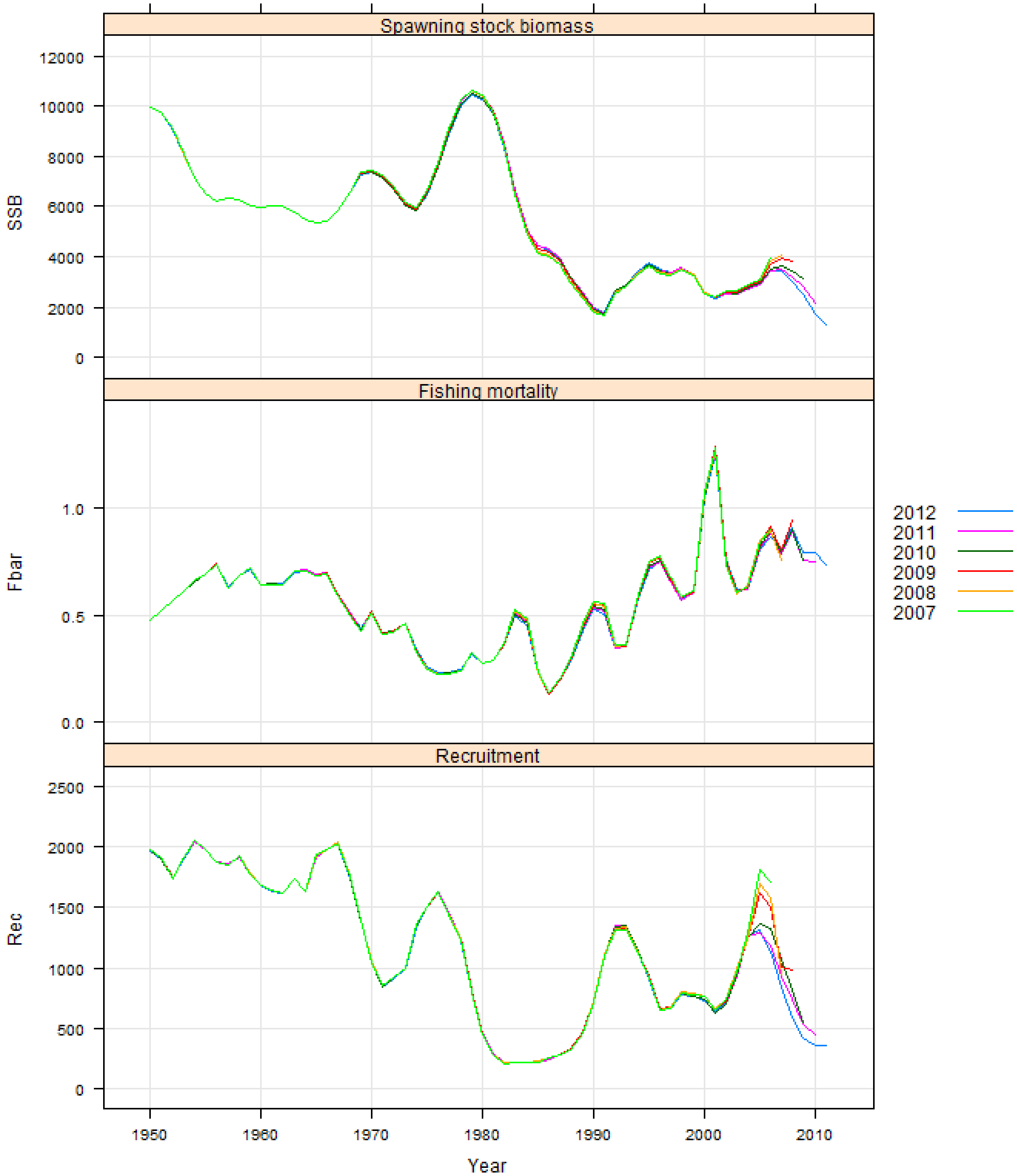


Figure 1.6.Black Sea turbot. Final run.. Analytical retrospective pattern over years, in the assessment for spawning stock biomass, recruitment and mean fishing mortality in the ages 3-6 ringer. The shaded area shows 95% CI on the final assess-ment.

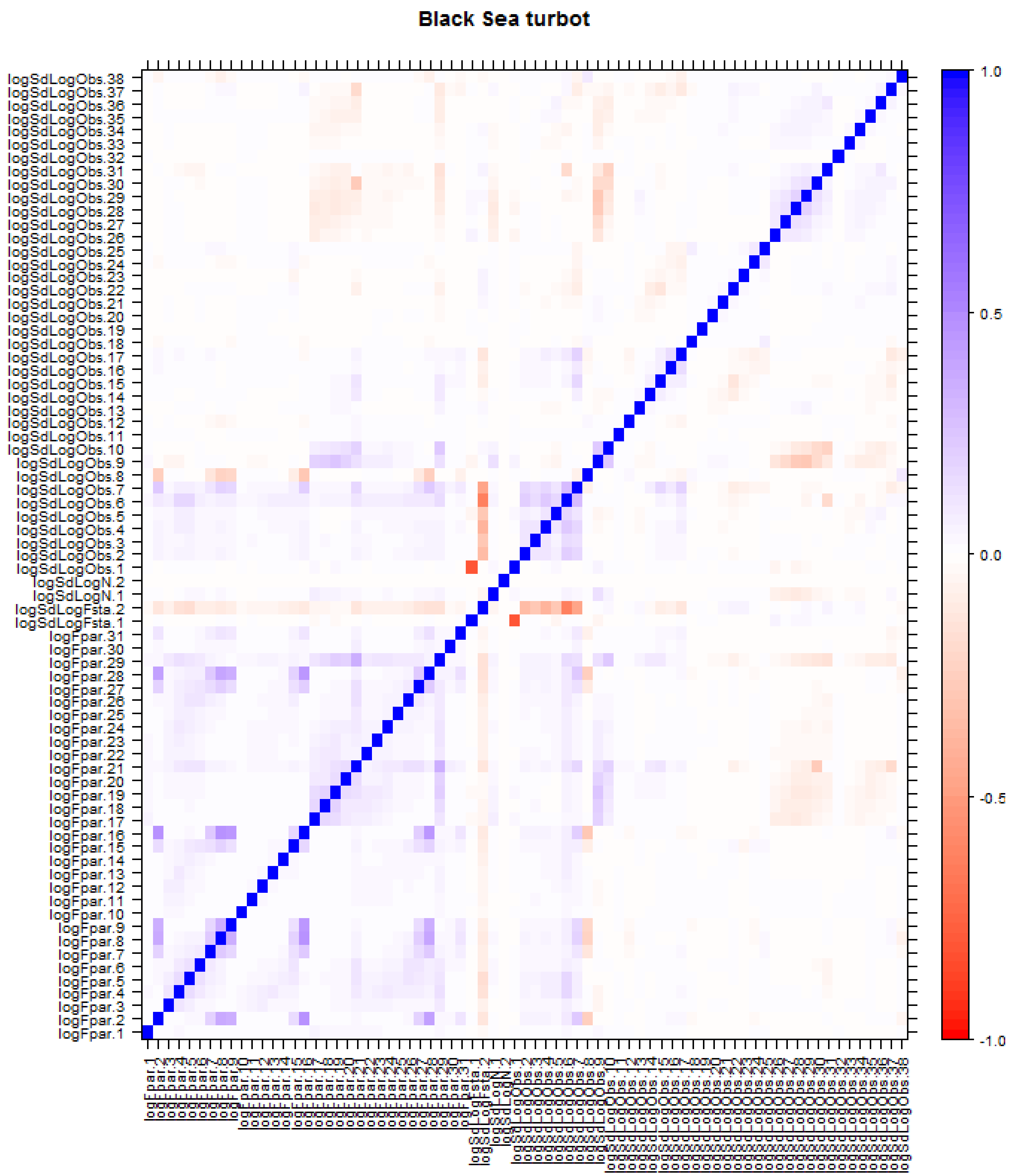


Figure 1.7.Black Sea turbot. Final run. Plot of all the estimat-ed parameters cross-correlation.

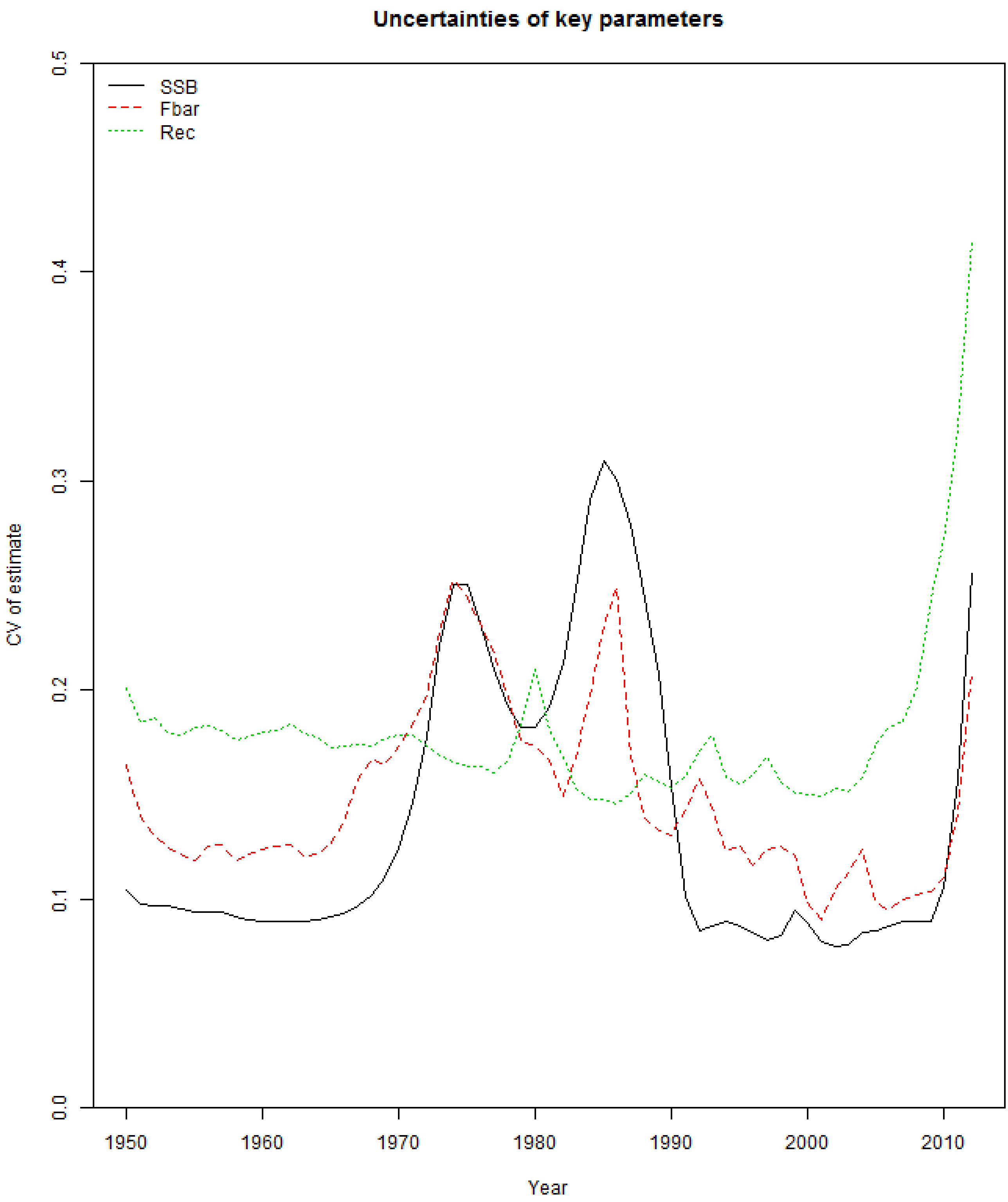


Figure 1.8.Black Sea turbot. Final run. Coefficient of variation (CV) of the main stock parameters.

9 APPENDIX 2: EWG-13-12 LIST OF PARTICIPANTS

[1] - Information on STECF members and invited experts' affiliations is displayed for information only. In some instances the details given below for STECF members may differ from that provided in Commission COMMISSION DECISION of 27 October 2010 on the appointment of members of the STECF (2010/C 292/04) as some members' employment details may have changed or have been subject to organisational changes in their main place of employment. In any case, as outlined in Article 13 of the Commission Decision (2005/629/EU and 2010/74/EU) on STECF, Members of the STECF, invited experts, and JRC experts shall act independently of Member States or stakeholders. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and invited experts make declarations of commitment (yearly for STECF members) to act independently in the public interest of the European Union. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

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European Commission

EUR 26228 EN – Joint Research Centre – Institute for the Protection and Security of the Citizen

Title: Scientific, Technical and Economic Committee for Fisheries - Assessment of Black Sea stocks (STECF-13-20).

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Luxembourg: Publications Office of the European Union

2013 – 429 pp. – 21 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424 (online), ISSN 1018-5593 (print)

ISBN 978-92-79-33772-7

doi:10.2788/34535

Abstract

The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 13-12 was held from 30 September – 4 October 2013 in Ispra, Italy to assess the status of demersal and small pelagic stocks in the Mediterranean Sea against the proposed FMSY reference point. The report was reviewed by the STECF by written procedure in October 2013.

LB-NA-26628-EN-N

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

Publications Office

ISBN 978-92-79-33772-7